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Liang et al.

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(54) **INTERNAL VENTING MECHANISMS FOR AUDIO SYSTEM WITH NON-POROUS MEMBRANE**

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(60) Provisional application No. 63/179,934, filed on Apr. 26, 2021, provisional application No. 63/083,045, filed on Sep. 24, 2020.

(51) **Int. Cl.**

H04R 1/02	(2006.01)
H04R 1/44	(2006.01)
H04R 9/06	(2006.01)

(52) **U.S. Cl.**

CPC ***H04R 1/023*** (2013.01); ***H04R 1/44*** (2013.01); *H04R 1/028* (2013.01); *H04R 9/06* (2013.01); *H04R 2201/023* (2013.01); *H04R 2400/11* (2013.01); *H04R 2499/11* (2013.01)

(58) **Field of Classification Search**

CPC H04R 1/023; H04R 1/44; H04R 1/028; H04R 9/06; H04R 2201/023; H04R 2400/01; H04R 2499/11; H04R 1/086; H04R 1/2826; H04R 1/02; H04R 1/08;

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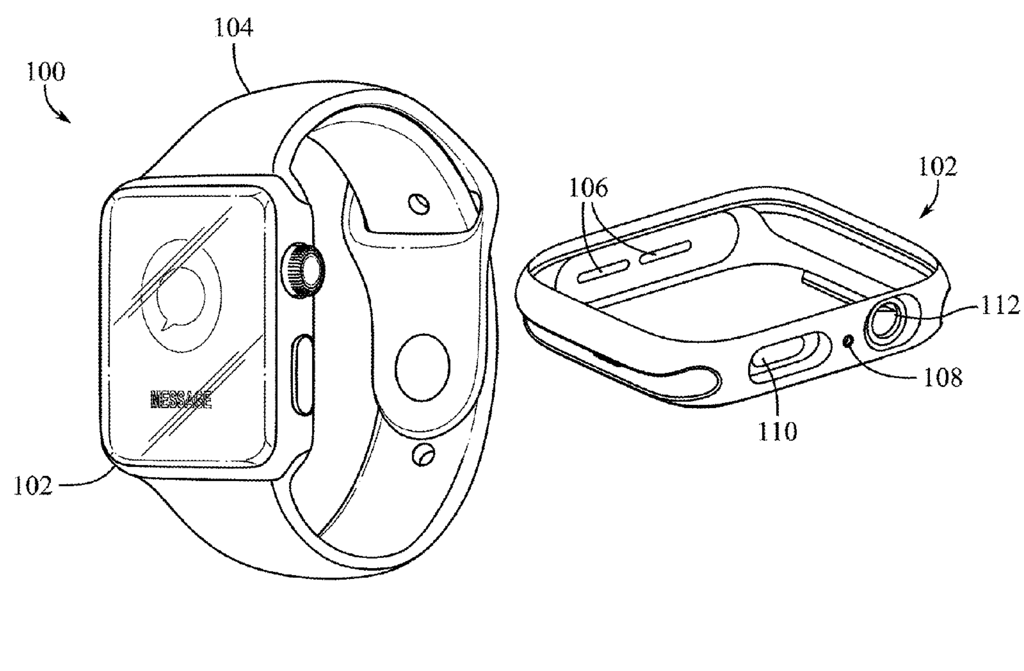
(57) **ABSTRACT**

An electronic device can include a housing, an audio component, and a gasket. The housing can define a first internal volume and the audio component can define a second internal volume. The audio component can include membrane and a venting element having a fluid impermeable layer. The venting element can define a fluid path placing the first internal volume and the second internal volume in fluid communication. At least a portion of the fluid path can extend parallel to the fluid impermeable layer. The gasket can define a seal between the first internal volume and an ambient environment adjacent the housing.

20 Claims, 12 Drawing Sheets



(58) **Field of Classification Search**
CPC H04M 1/18; H05K 5/02; H05K 5/0213; H05K 5/061
See application file for complete search history.

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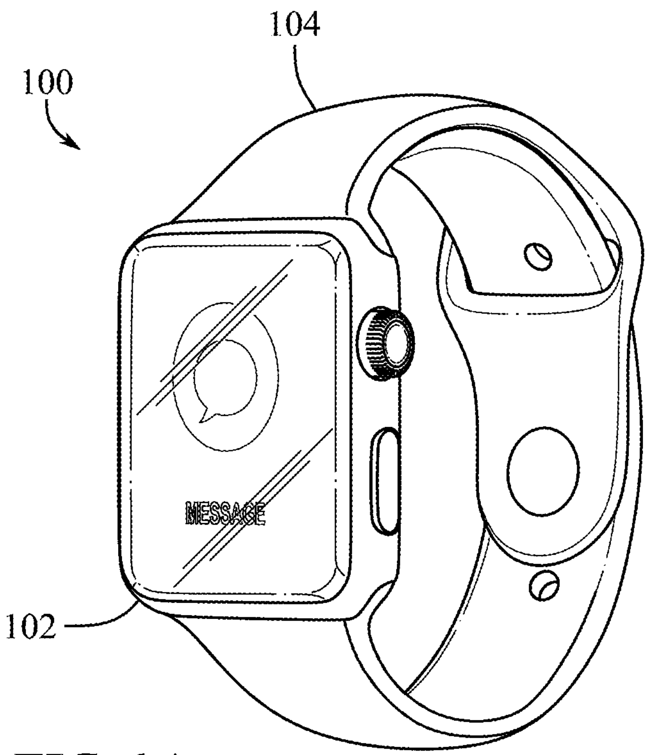

FIG. 1A

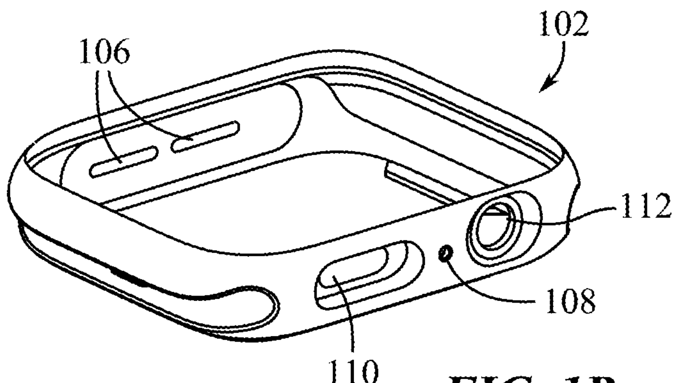

FIG. 1B

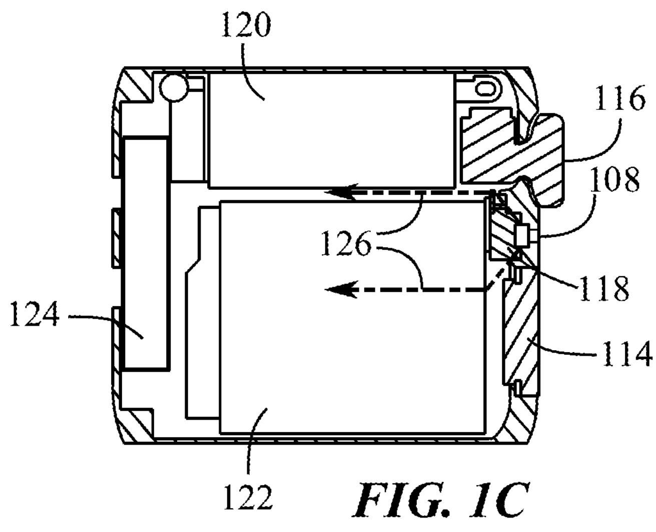

FIG. 1C

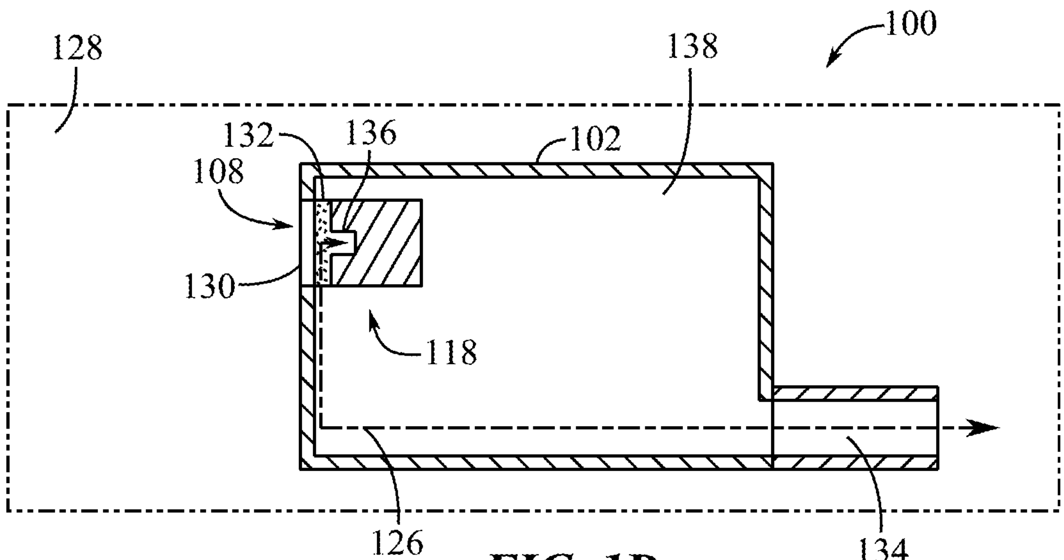
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FIG. 1D

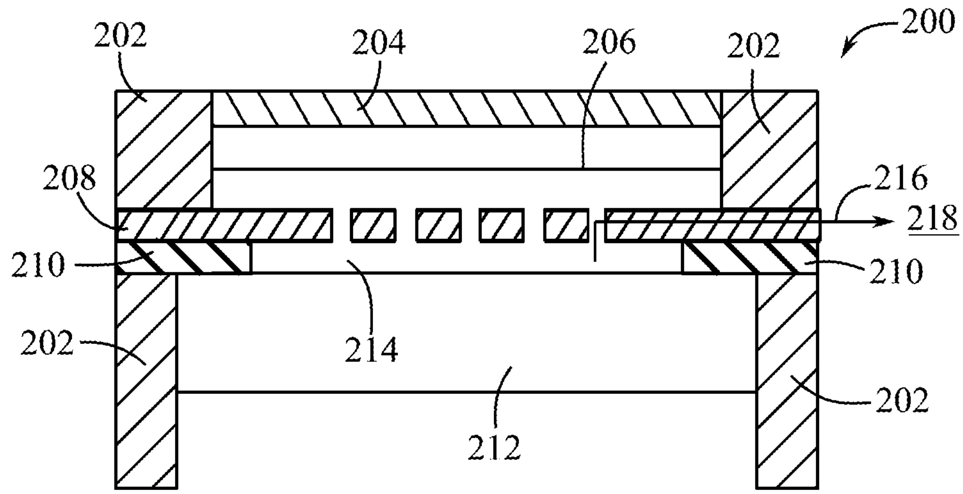
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FIG. 2

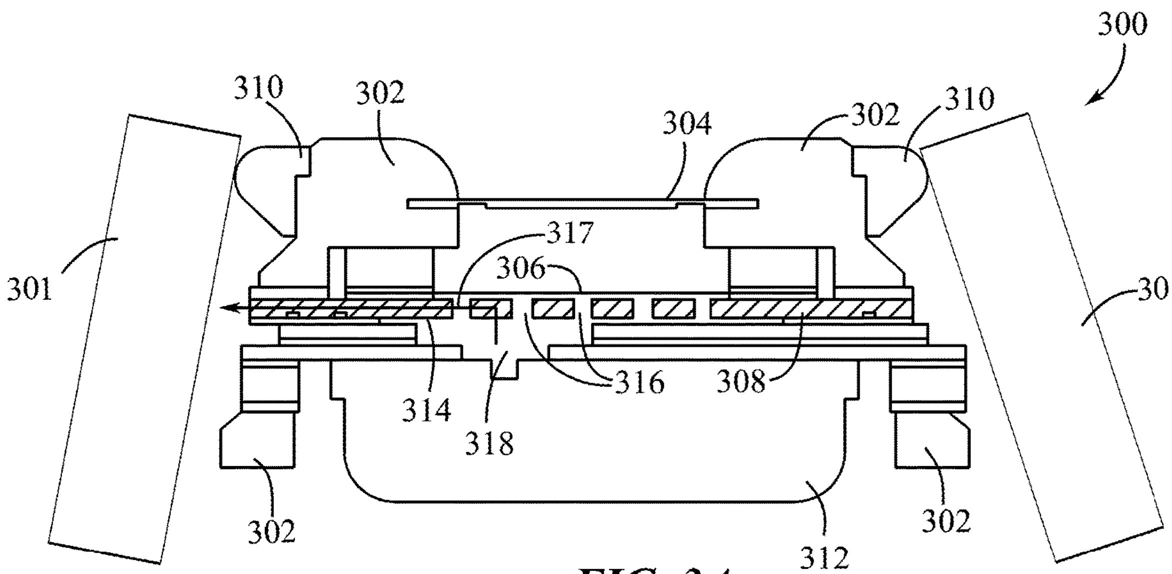

FIG. 3A

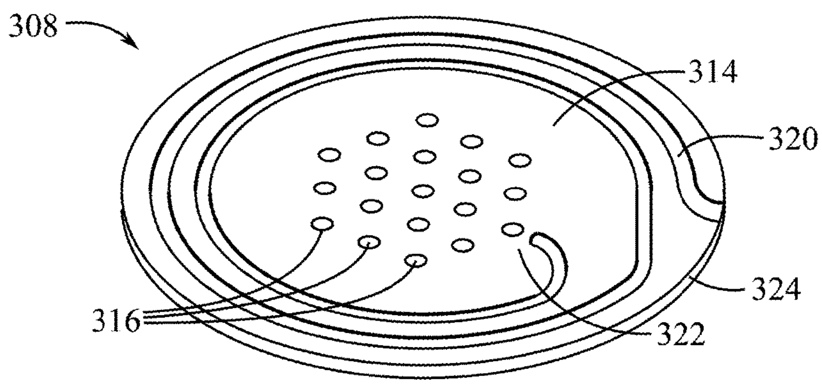

FIG. 3B

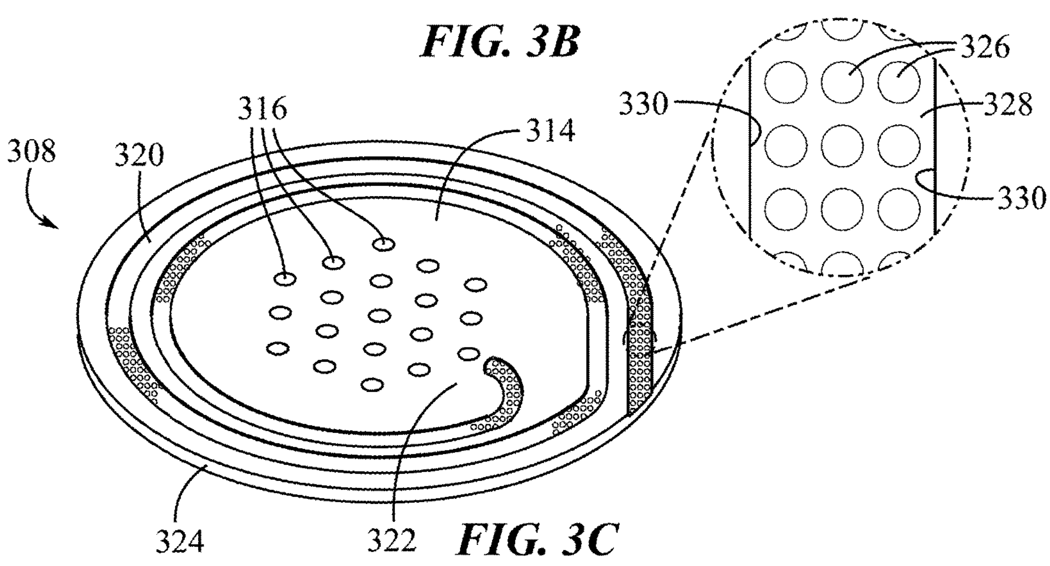

FIG. 3C

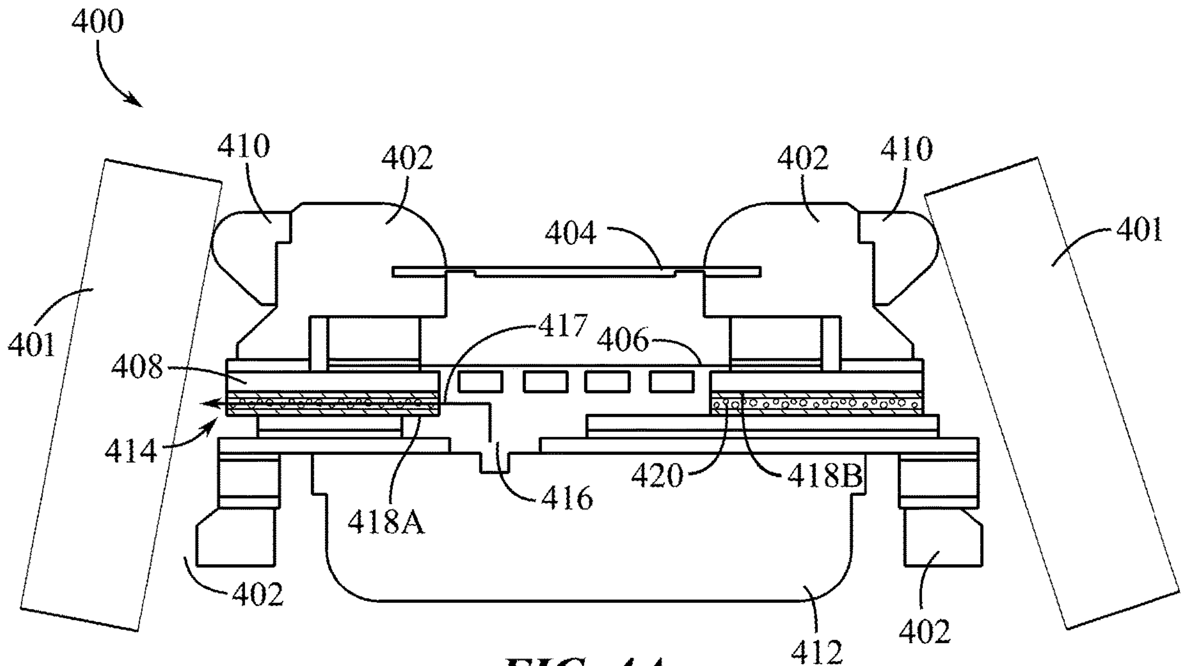

FIG. 4A

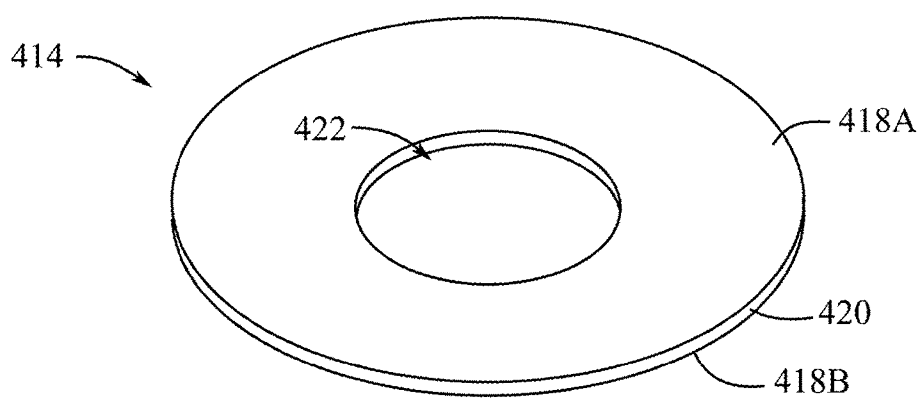

FIG. 4B

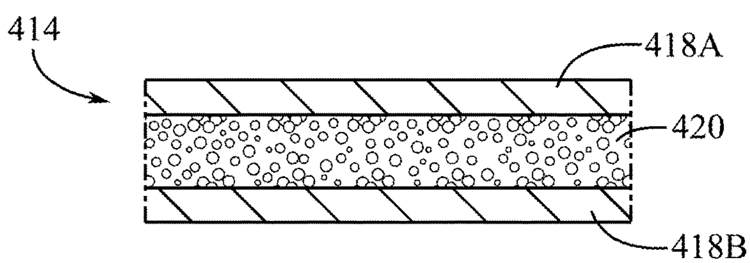

FIG. 4C

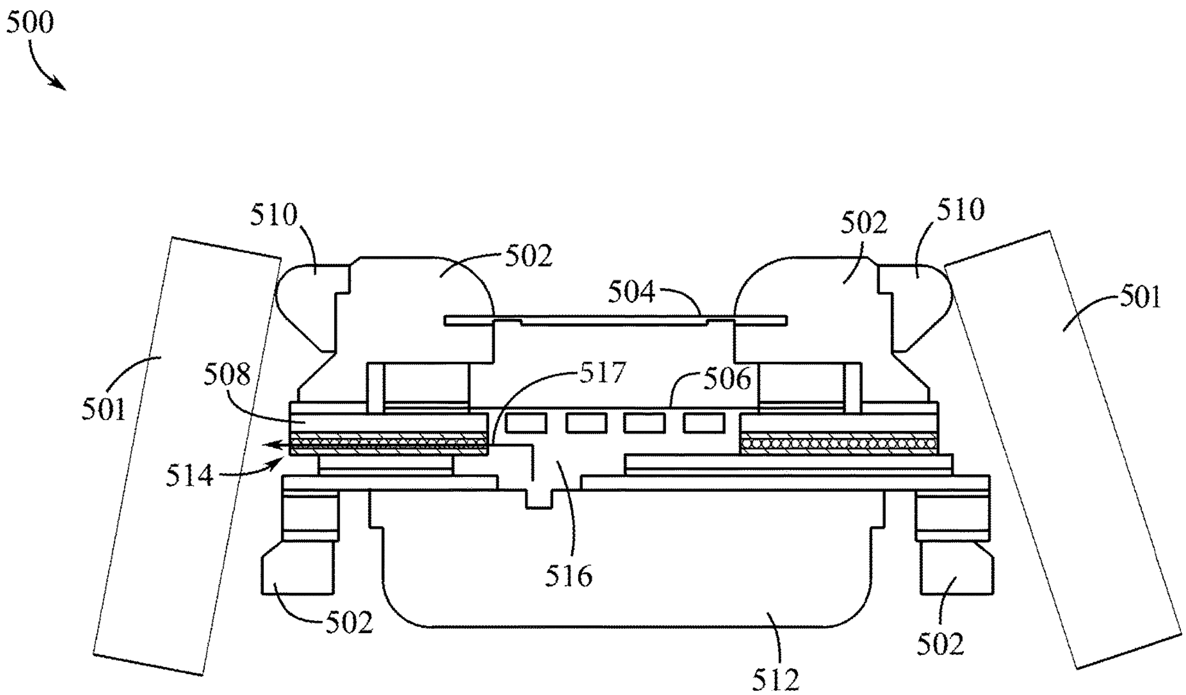

FIG. 5A

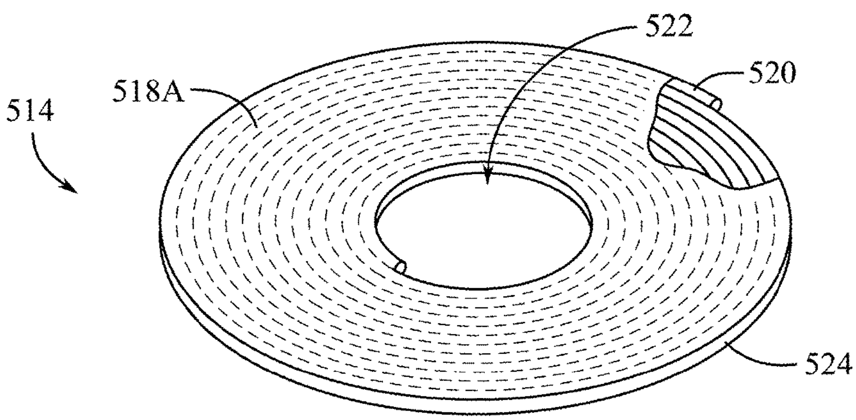

FIG. 5B

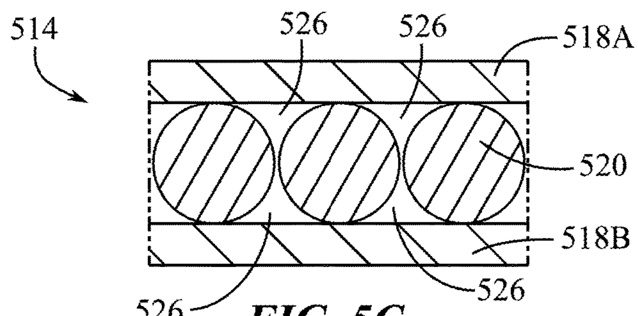

FIG. 5C

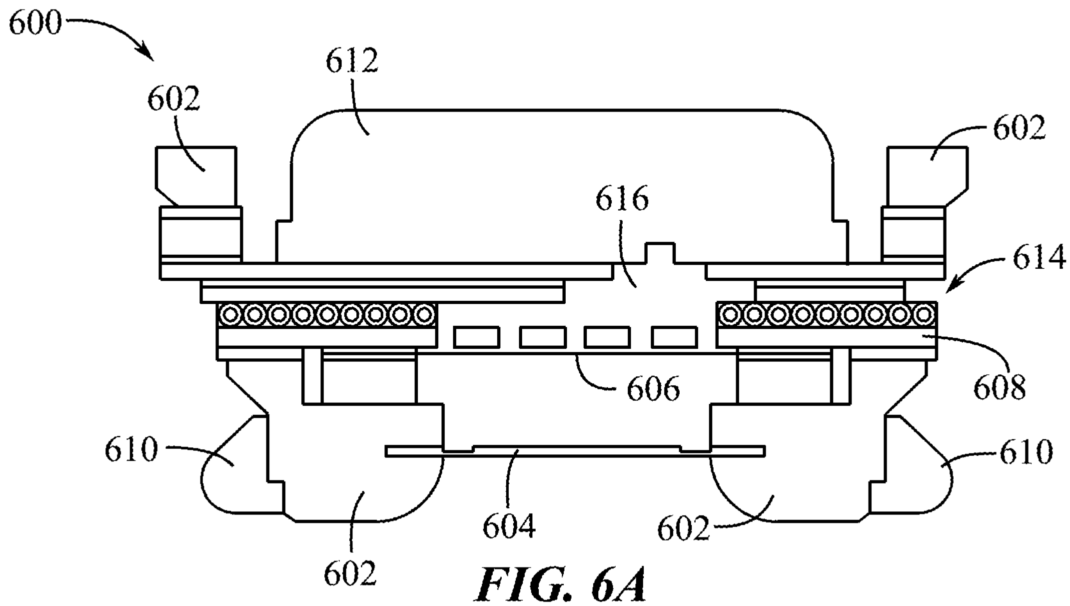

FIG. 6A

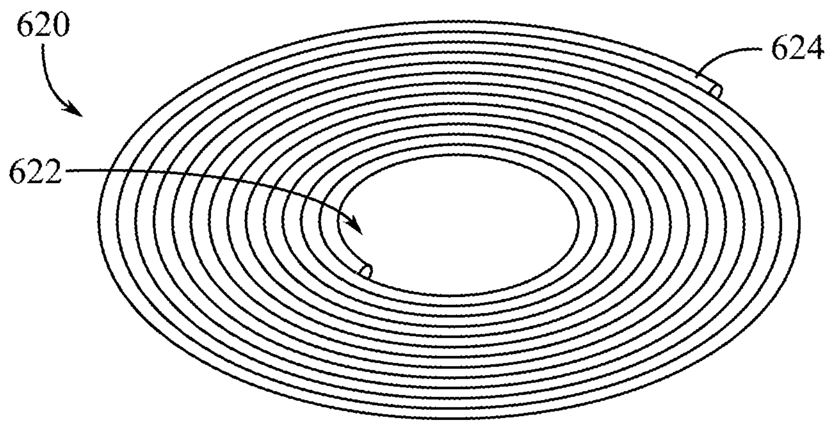

FIG. 6B

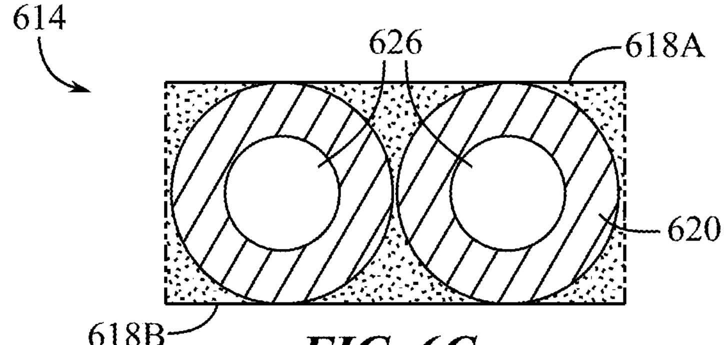

FIG. 6C

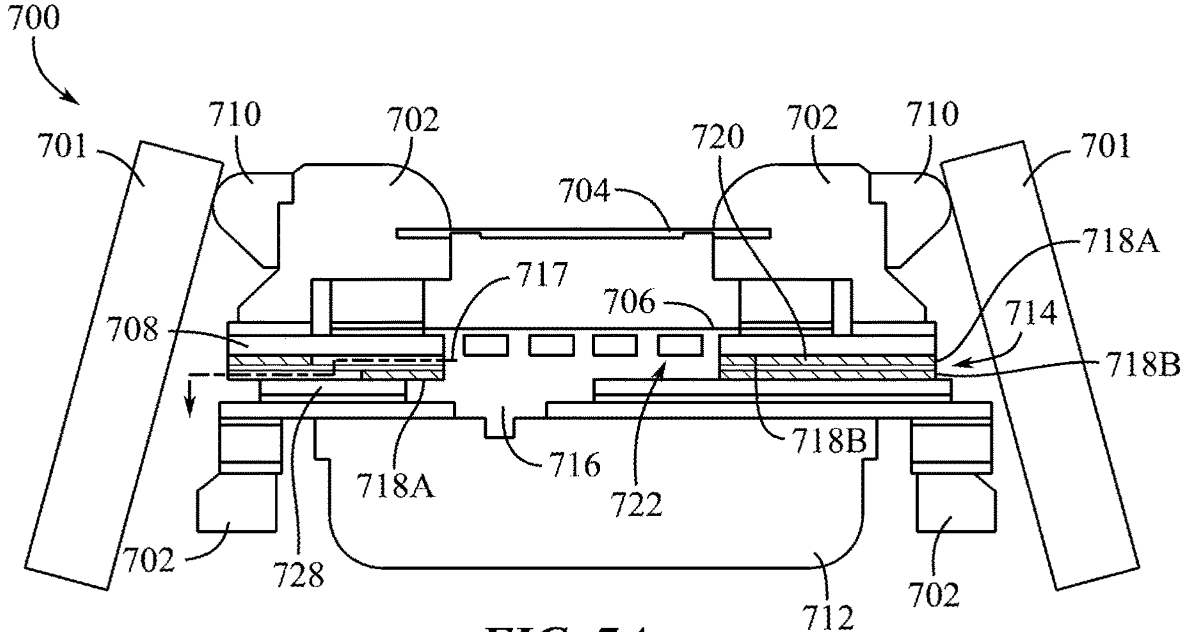
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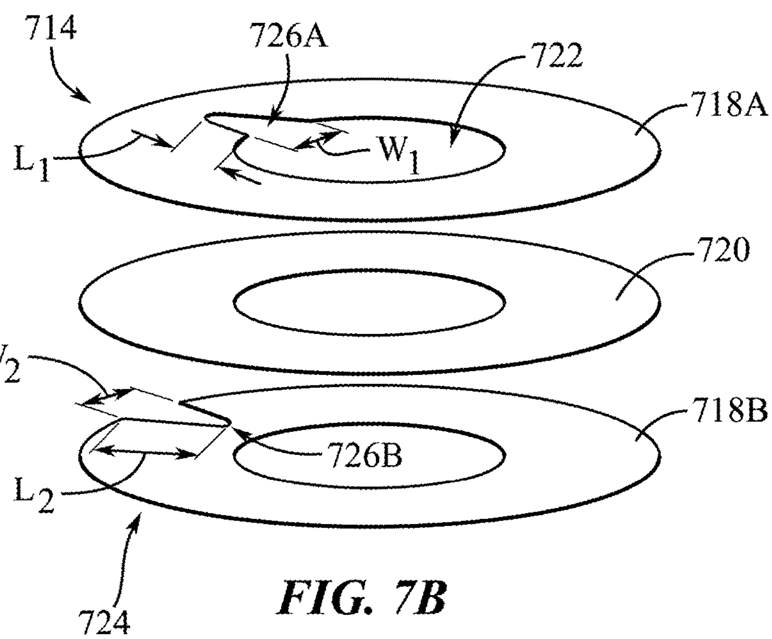
FIG. 7A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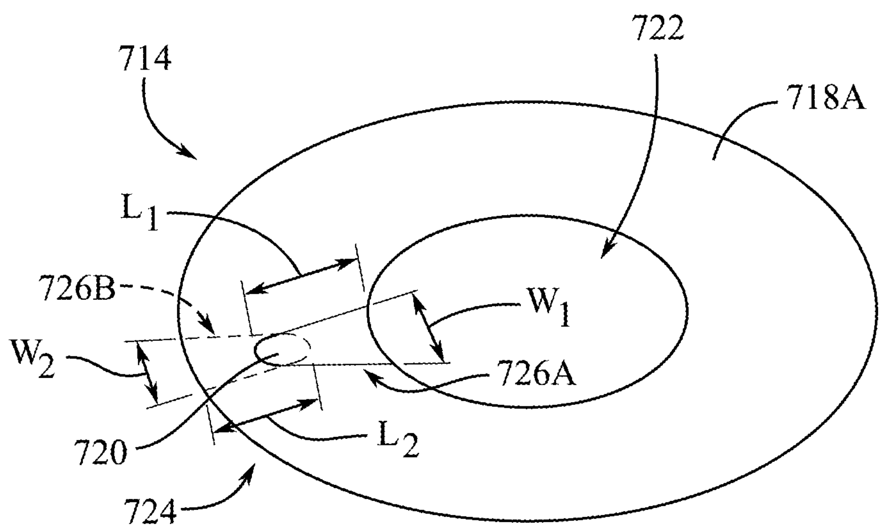
726B
L2
724

FIG. 7B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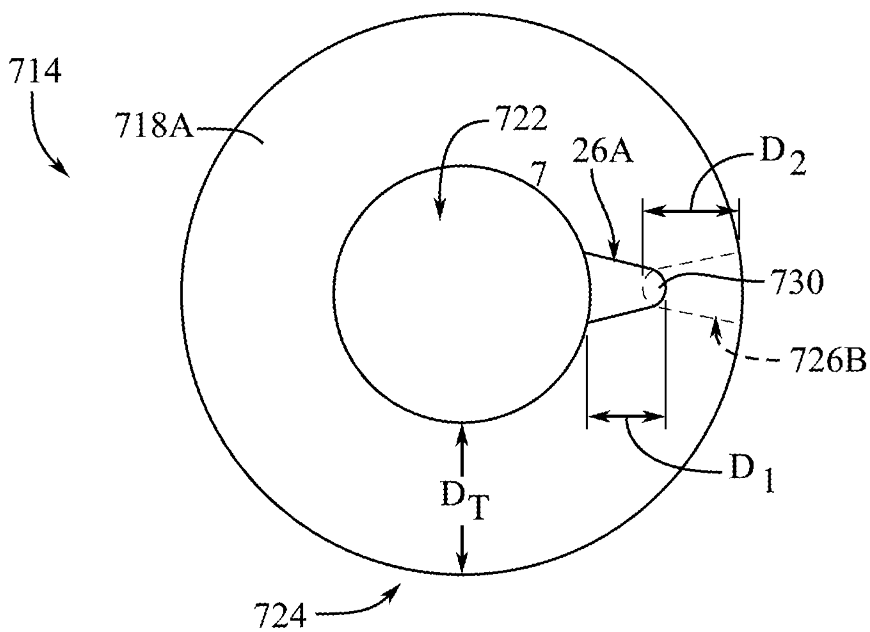
L1
726B
W1
W2
726A
720
L2
724

FIG. 7C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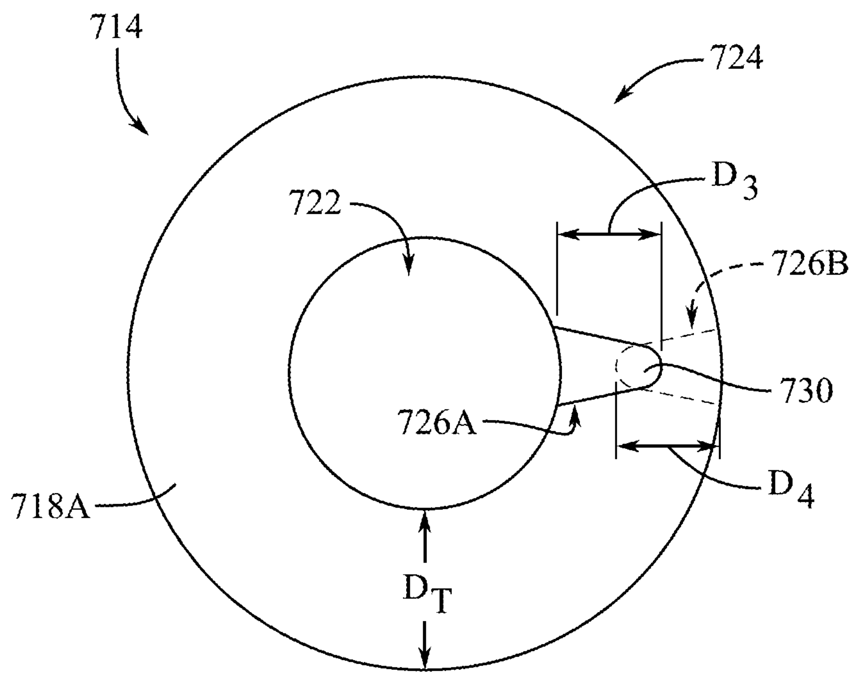
26A
7
D2
730
726B
D1
DT
724

FIG. 7D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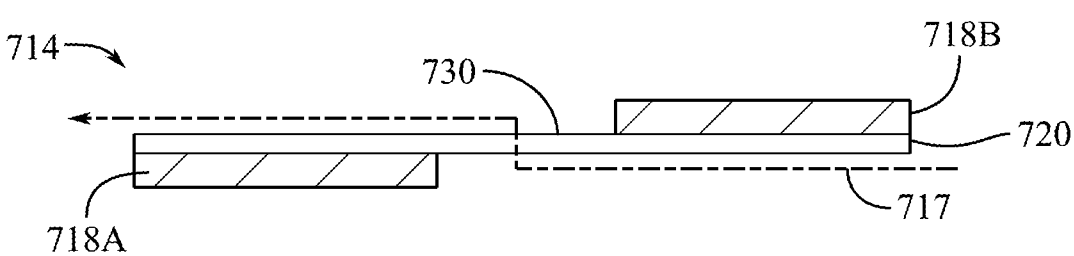
724
722
D_3
726B
730
726A
718A
D_4
D_T

FIG. 7E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730
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717
718A

FIG. 7F

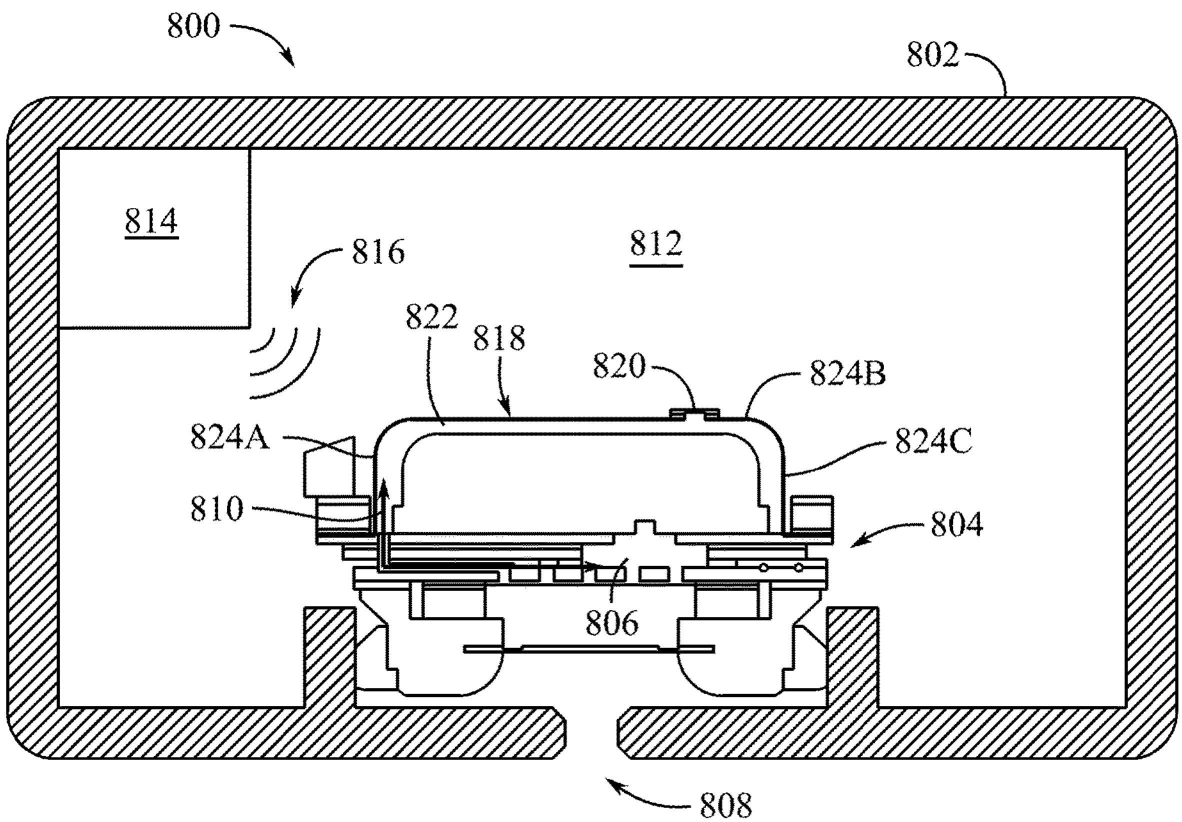


FIG. 8

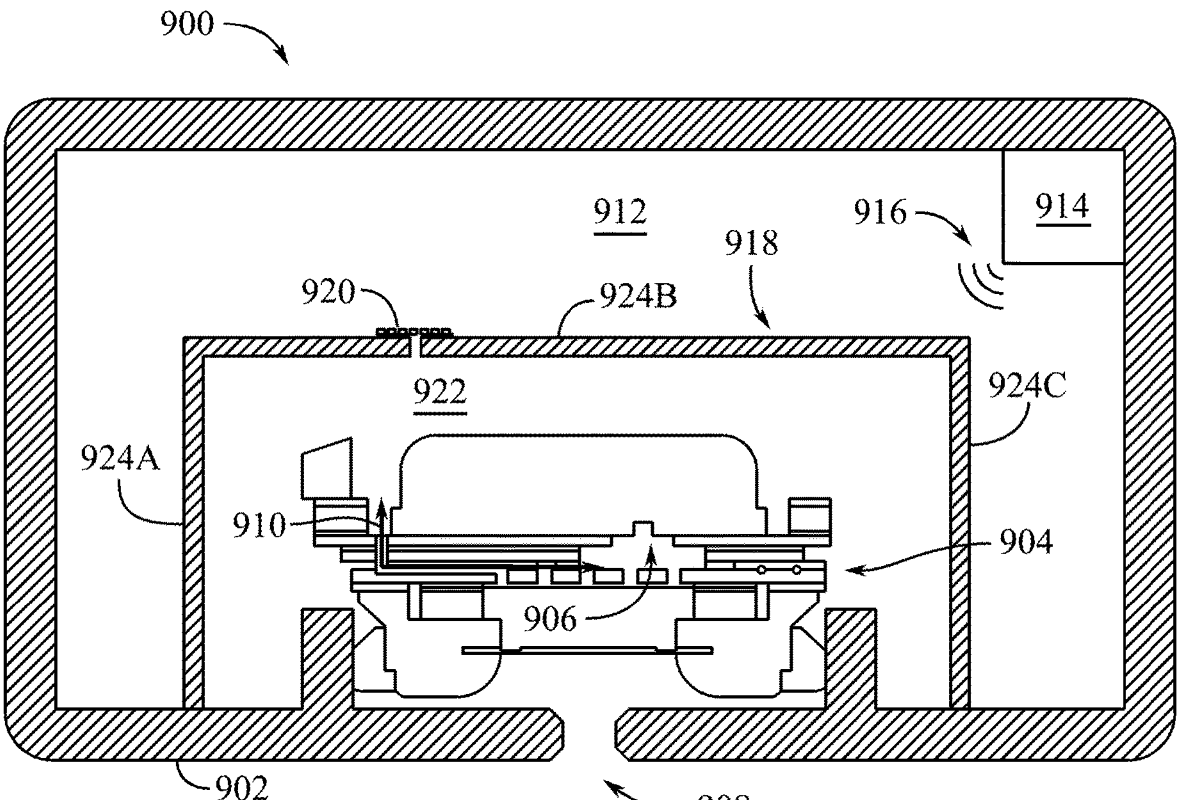
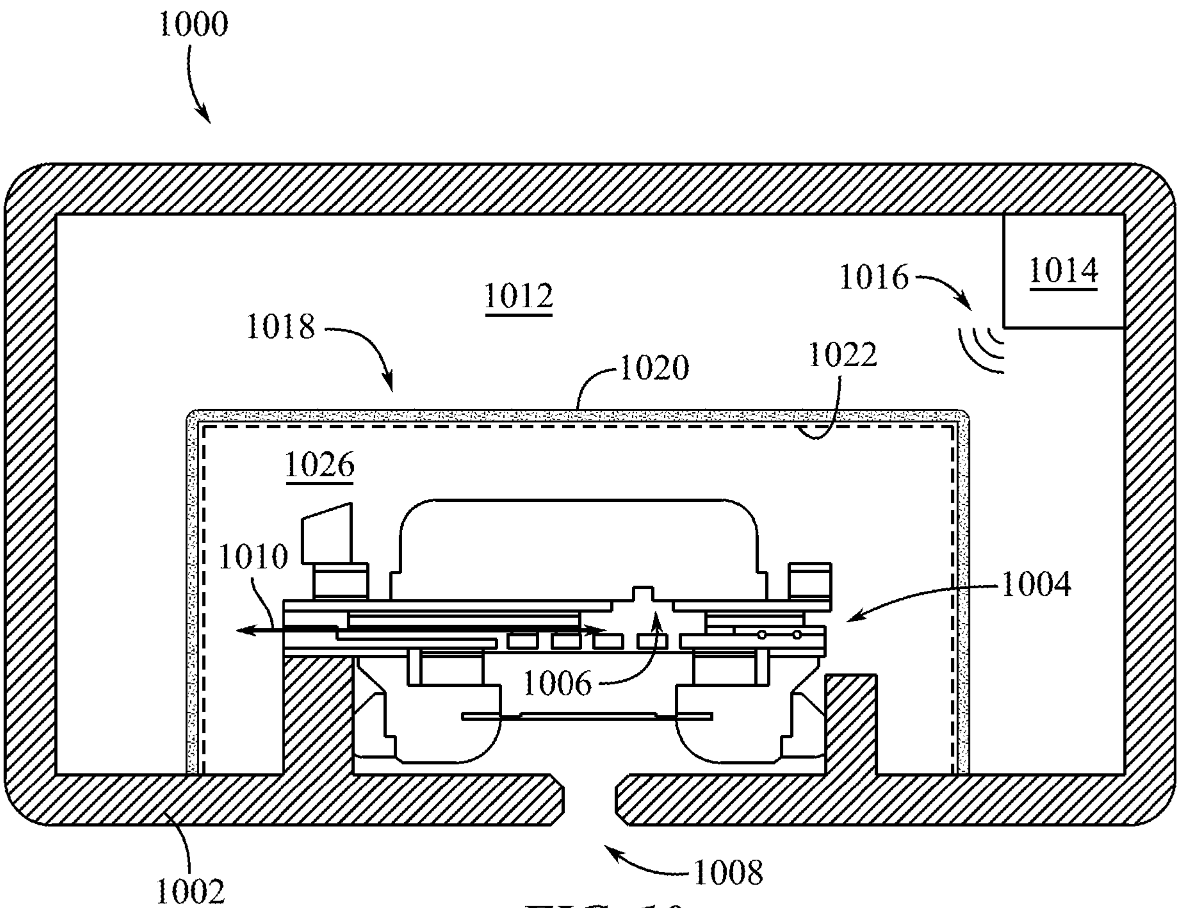


FIG. 9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1012
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1010
1004
1006
1002
1008

FIG. 10

INTERNAL VENTING MECHANISMS FOR AUDIO SYSTEM WITH NON-POROUS MEMBRANE

CROSS-REFERENCE TO RELATED APPLICATION(S)

This is a continuation of U.S. patent application Ser. No. 17/445,931, filed 25 Aug. 2021, and entitled "Internal Venting Mechanisms for Audio System with Non-Porous Membrane," which claims priority to U.S. Provisional Patent Application No. 63/179,934, filed 26 Apr. 2021, and entitled "INTERNAL VENTING MECHANISMS FOR AUDIO SYSTEM WITH NON-POROUS MEMBRANE," and to U.S. Provisional Patent Application No. 63/083,045, filed 24 Sep. 2020, and entitled "INTERNAL VENTING MECHANISMS FOR AUDIO SYSTEM WITH NON-POROUS MEMBRANE," the entire disclosures of which are hereby incorporated by reference.

FIELD

The described examples relate generally to electronic devices. More particularly, the present examples relate to venting electronic devices.

BACKGROUND

Recent advances in electronics have driven electronic devices to encompass smaller form factors while providing increased battery life, performance, and durability. These attributes have contributed to electronic devices, such as smartwatches, which are portable and used in a variety of activities, such as, swimming, travel, exercise, scuba-diving, mountain climbing, backpacking, snorkeling, camping, fishing, biking, and other activities. Indeed, portable electronic devices provide instantaneous resources related to indoor and outdoor activities, such as, monitoring or measuring heartrate, location information, atmospheric pressure, and the like. While portable electronic devices are desirable in a broad range of activities, attributes of the environment in which the portable electronic device is used like temperature, humidity, and pressure can significantly impact the performance and functionality of electronic components within the portable electronic device. Thus, improvements and advances to portable electronic devices can be desirable to withstand environmental attributes without inhibiting the functionality of the electronic device.

SUMMARY

According to some aspects of the present disclosure, an electronic device can include a housing at least partially defining a first internal volume, and an audio component defining a second internal volume. The audio component can include a membrane and a venting element. The venting element can define a fluid path extending from the first internal volume to the second internal volume and place the first internal volume in fluid communication with the second internal volume.

In some examples, the audio component includes a microphone. The electronic device can be a smartwatch or a smartphone in some examples. The venting element can include a fluid impermeable layer and at least a portion of the fluid path can extend parallel to the fluid impermeable layer. The fluid impermeable layer can define a channel extending from a central portion of the venting element to a

periphery of the venting element. The channel can form at least a portion of the fluid path. The venting element can include a porous material disposed adjacent the fluid impermeable layer. The porous material can define the fluid path. The porous material can include metal. The venting element can include a coil coupled to the fluid impermeable layer in some examples. The coil can at least partially define the fluid path.

In some examples, the venting element can include a first layer at least partially defining a first channel extending into the first layer from a central portion of the venting element. The venting element can include a second layer at least partially defining a second channel extending into the second layer from a periphery of the venting element. The venting element can include a fluid permeable intermediate layer disposed between the first layer and the second layer. The fluid permeable intermediate layer can place the first and second channels in fluid communication.

According to some examples, an audio component can include a case at least partially defining an internal volume, a membrane at least partially defining the internal volume, and a venting element in fluid communication with the internal volume. The venting element can define a fluid path extending the internal volume an ambient environment external to the case.

In some examples, the fluid path can extend from a central portion of the venting element to a periphery of the venting element. In some examples, the venting element can include a first layer at least partially defining a first channel extending into the first layer from a central portion of the venting element. The venting element can include a second layer at least partially defining a second channel extending into the second layer from a periphery of the venting element. The venting element can include a fluid permeable intermediate layer disposed between the first layer and the second layer. The fluid permeable intermediate layer can place the first and second channels in fluid communication. The first and second channels can extend parallel to the fluid permeable intermediate layer. A width of the first channel can vary along a length of the first channel. A width of the second channel can vary along a length of the second channel. A region of the fluid permeable intermediate layer disposed between the first and second channels can place the first and second channels in fluid communication.

The venting element can include a series of protrusions disposed along a length of the fluid path. In some examples, the venting element can include a first fluid impermeable layer, a second fluid impermeable layer, and a porous layer disposed between the first fluid impermeable layer and the second fluid impermeable layer. The porous layer can define the fluid path. The porous layer can include a metal foam. In some examples, the venting element can include a coiled member coupled to the fluid impermeable layer. At least a portion of the fluid path can be formed by the fluid impermeable layer and the coiled member. In some examples, the venting element can include a coiled member coupled to the fluid impermeable layer. The coiled member can define a conduit extending through the coiled member and at least a portion of the fluid path can be formed by the conduit. The audio component can be a speaker or a microphone.

According to some aspects of the present disclosure, a venting element for a portable electronic device can include a fluid impermeable layer defining a surface of the venting element. The venting element can include a fluid permeable layer disposed adjacent the fluid impermeable layer. The fluid permeable layer can define a fluid path extending from a central portion of the venting element to a periphery of the venting element.

In some examples, the fluid permeable layer can define a channel extending from a central portion of the venting element toward a periphery of the venting element. The channel can form at least a portion of the fluid path. The fluid permeable layer can include a foam in some examples. The fluid permeable layer can include a coiled tubular member in some examples.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosure will be readily understood by the following detailed description in conjunction with the accompanying drawings, wherein like reference numerals designate like structural elements, and in which:

FIG. **1**A shows a perspective view of a portable electronic device.

FIG. **1**B shows a perspective view of a housing of the portable electronic device of FIG. **1**A.

FIG. **1**C shows a top cross-sectional view of the portable electronic device of FIG. **1**A.

FIG. **1**D shows a block diagram of a portable electronic device.

FIG. **2** shows a cross-sectional side view of an audio component assembly.

FIG. **3**A shows a cross-sectional side view of an audio component assembly.

FIG. **3**B shows a top perspective view of a venting element.

FIG. **3**C shows a top perspective view of a venting element.

FIG. **4**A shows a cross-sectional side view of an audio component assembly.

FIG. **4**B shows a top perspective view of a venting element.

FIG. **4**C shows a cross-sectional side view of the venting element of FIG. **4**B.

FIG. **5**A shows a cross-sectional side view of an audio component assembly.

FIG. **5**B shows a top perspective view of a venting element.

FIG. **5**C shows a cross-sectional side view of the venting element of FIG. **5**B.

FIG. **6**A shows a cross-sectional side view of an audio component assembly.

FIG. **6**B shows a top perspective view of a venting element.

FIG. **6**C shows a cross-sectional side view of the venting element of FIG. **6**B.

FIG. **7**A shows a cross-sectional side view of an audio component assembly.

FIG. **7**B shows an exploded view of a venting element.

FIG. **7**C shows a top perspective view of the venting element of FIG. **7**B.

FIG. **7**D shows a top view of an example of a venting element.

FIG. **7**E shows a top view of another example of a venting element.

FIG. **7**F shows a cross-sectional side view of the venting element of FIG. **7**B.

FIG. **8** shows a cross-sectional side view of a portable electronic device.

FIG. **9** shows a cross-sectional side view of a portable electronic device.

FIG. **10** shows a cross-sectional side view of a portable electronic device.

DETAILED DESCRIPTION

The present description provides examples, and is not limiting of the scope, applicability, or configuration set forth in the claims. Thus, it will be understood that changes can be made in the function and arrangement of elements discussed, without departing from the spirit and scope of the disclosure, and various examples can omit, substitute, or add other procedures or components, as appropriate. Also, features described with respect to some examples can be combined in other examples.

Portable electronic devices can utilize electronic components having one or more membranes, such as, audio components like speakers or microphones, barometric vents, etc. For example, a microphone can include a membrane which moves relative to acoustic waves exerted on the membrane. Electronic and/or electrical components within the microphone can convert the movement of the membrane into electrical signals which can be communicated to other components of the portable electronic device. The membrane and microphone housing can define a volume which experiences a variance in relative pressure (e.g., a pressure within the volume relative to a pressure of an ambient environment outside of the volume). For example, temperature and/or atmospheric pressure resultant of submersion within a liquid can vary the relative pressure within the volume. Fluctuations in relative pressure can degrade operation of the membrane or otherwise cause the microphone to perform poorly. Accordingly, venting the volume defined by the membrane and microphone housing can be beneficial to regulate the relative pressure within the volume. One option for venting the membrane utilizes a porous membrane which can vent fluid through the membrane itself. However, porous membranes can expose the portable electronic device to ingress of contaminants, such as, dust, sand, debris, fluid, corrosive materials, and other types of organic and inorganic materials.

The present disclosure relates to venting elements having features which define a fluid path placing a first internal volume of the portable electronic device in fluid communication with a second internal volume of the portable electronic device. For example, a portable electronic device can include a housing which defines a first internal volume and the portable electronic device can include an audio component, such as, a microphone assembly, speaker assembly, or other audio component which forms a second internal volume. The audio component can include a venting element at least partially disposed within the second internal volume. The venting element can include one or more fluid impermeable layers. The venting element can define a fluid path having portions which extend parallel to the one or more fluid impermeable layers and placing the first internal volume and the second internal volume in fluid communication. Thus, the venting element can provide a vent or fluid path between the audio component and the housing to regulate a relative pressure within the first volume. In some examples the first internal volume can be in fluid communication with the ambient environment outside of the housing by a barometric vent disposed within a sidewall of the housing.

Portable electronic devices are trending toward smaller form factors or are otherwise trending toward electronic components which take up less space within the housing of the portable electronic device. This trend can cause multiple electronic components to be packaged tightly within the housing, disposed within a common internal volume. However, packaging components within a relatively small and confined space can present challenges, for example, the operation of one electronic component can diminish or degrade the efficient operation of another electronic component. A microphone, for example, can be disposed within a housing and can be required to vent through the same portion of the housing that forms the back-volume for a speaker of the portable electronic device. In this example, the fluid path defined by the microphone to vent relative pressure can also enable acoustic waves from the speaker to travel to the microphone (e.g., through the fluid path) and thereby decrease or diminish the functionality of the microphone.

Some aspects of the present disclosure relate to venting elements which define fluid paths while also attenuating or reducing acoustic waves having wavelengths between 20 Hz and 20 kHz. In other words, the fluid path defined by the venting element can act as a low-pass filter which permits airflow through the fluid path while also attenuating acoustic waves above 20 Hz. For example, layers of a venting element can define one or more channels which form at least part of a fluid path. The one or more channels can extend from a central portion of the venting element toward a periphery of the venting element. In some examples, two channels can be placed in fluid communication by a fluid permeable intermediate layer disposed between the two channels. In some examples, the fluid permeable intermediate layer can enable fluid flow between the two channels but prevent or inhibit acoustic waves from entering the second internal volume (e.g., the volume defined by the audio component).

As another example, a venting element can include a porous layer disposed between first and second fluid impermeable layers. The porous layer can include a metal foam. As another example, a venting element can include a coiled member coupled to a fluid impermeable layer and a fluid path can be defined between the coiled member and the fluid impermeable layer. In some examples, the coiled member can form a hollow passage or conduit (e.g., a hollow coiled tube) and at least a portion of the fluid path can be defined by the passage conduit.

While membrane supports and venting elements are described herein as distinct and individual components of the audio component assembly in some examples, those skilled in the art will readily appreciate that the venting element can act as a membrane support in some examples (see FIGS. **3A-3C**) and can therefore define a fluid path which places two or more volumes in fluid communication. Any of the following examples depicted in FIGS. **1A-7F** can be implemented with a venting element that functions as a membrane support or can be otherwise implemented with a membrane support and a distinct venting element. Thus, any functionality or features described herein relating to venting elements can be equally applicable to membrane supports and vice versa.

In another aspect of the present disclosure, an enclosure or cap can be positioned over at least a portion of the audio component to prevent or inhibit ancillary acoustic waves from negatively impacting the performance of the audio component. For example, while a microphone and a speaker are each in fluid communication with a common volume (e.g., a volume formed by the housing of a portable electronic device), acoustic waves generated by the speaker can propagate into a volume of the microphone and degrade or otherwise interfere with the performance of the microphone. The enclosure or cap can enable fluid communication between the microphone and the volume while simultaneously preventing or inhibiting the acoustic waves generated by the speaker from degrading performance of the audio component.

In examples, the enclosure or cap can be fluid impermeable except at a vent. The vent can enable fluid communication between the microphone and the volume such that a pressure differential between the microphone and an ambient environment can be equalized. The enclosure or cap can be directly coupled to the audio component, the housing of the portable electronic device, or a combination thereof. In some examples, the enclosure or cap can be formed from a material that enables fluid communication but otherwise at least partially attenuates acoustic waves. For example, the enclosure or cap can include a porous material, such as, a metallic or elastomeric open-cell foam. These and other examples are discussed below with reference to FIGS. **8-10**.

The detailed description given herein with respect to these Figures is for explanatory purposes only and should not be construed as limiting. Furthermore, as used herein, a system, a method, an article, a component, a feature, or a sub-feature comprising at least one of a first option, a second option, or a third option should be understood as referring to a system, a method, an article, a component, a feature, or a sub-feature that can include one of each listed option (e.g., only one of the first option, only one of the second option, or only one of the third option), multiple of a single listed option (e.g., two or more of the first option), two options simultaneously (e.g., one of the first option and one of the second option), or combination thereof (e.g., two of the first option and one of the second option).

FIG. **1A** shows an example of a portable electronic device **100**. The portable electronic device **100** shown in FIG. **1A** is a watch, such as a smartwatch. The smartwatch of FIG. **1A** is merely one representative example of a device that can be used in conjunction with the systems and methods disclosed herein. The portable electronic device **100** can correspond to any form of wearable electronic device, a portable media player, a media storage device, a portable digital assistant ("PDA"), a tablet computer, a computer, a mobile communication device, a GPS unit, a remote control device, or other electronic device. The portable electronic device **100** can also be referred to as an electronic device, or a consumer device. In some examples, the portable electronic device **100** can include a housing **102** that can carry operational components, for example, in an internal volume at least partially defined by the housing **102**. The electronic device **100** can also include a strap **104**, or other retaining component that can secured the device **100** to a body of a user, as desired. Further details of the portable electronic device **100** are provided below with reference to FIG. **1B**.

FIG. **1B** shows the housing **102** depicted in FIG. **1A**. The housing **102** can be a substantially continuous or unitary component, and can define one or more openings **106**, **108**, **110**, **112** to receive components of the portable electronic device **100** and/or to provide access to an internal portion of the electronic device **100**. For example, one or more of the openings **106**, **108**, **110**, **112** can provide fluid communication between an ambient environment outside of the housing **102** and one or more internal volumes within the housing **102** and/or electronic components disposed within the housing **102**. The electronic components can be disposed within the internal volume defined at least partially by the housing **102**, and can be affixed to the housing **102** via adhesives, internal surfaces, attachment features, threaded connectors, studs, posts, or other features, that are formed into, defined by, or otherwise part of the housing **102** and/or a cover and/or back cover of the portable electronic device **100**.

FIG. **1**C shows a top cross-sectional view of the portable electronic device **100** depicted in FIG. **1**A. In some examples, the device **100** can include input components such as one or more buttons **114** and/or a crown **116** that can be disposed in the openings **110**, **112**. An audio component assembly **118** can be disposed in the internal volume in communication with the external or ambient environment through the opening **108**. In some examples, the audio component assembly **118** can include a microphone or speaker. Other electronic components can be disposed within the internal volume of the housing **102**, for example, a haptic feedback module **120**, a battery **122**, and a speaker **124**. While this disclosure only references a few specific electronic components of the portable electronic device **100**, it will be appreciated that the portable electronic device can include any number or variety of electronic components can be included in the portable electronic device **100**. For example, the portable electronic device **100** can include a display, a main logic board having a system in package (SiP), one or more antennas, wireless communication circuits, a camera, a second logic board, one or more sensors, and/or any other electronic component.

One or more of the electronic components disposed within the portable electronic device **100** can include a membrane (see FIGS. **2**-**6**C) which requires venting to regulate relative pressure within a volume and thereby avoid damaging the membrane (e.g., inelastic deformation caused by the relative pressure on the membrane) and/or enabling satisfactory operation of the electronic component. For example, the audio component assembly **118** can include a membrane which at least partially defines a volume within the audio component assembly **118**. This volume can require venting to regulate relative pressure within the volume and prevent damage to the membrane and enable efficient functionality of the audio component assembly **118**. In some examples, a venting element, such as, a membrane support or other component can define a fluid path between the volume of the audio component assembly **118** and the internal volume of the housing **102** (as illustrated by arrows **126** in FIG. **1**C). Thus, in some examples, the audio component assembly **118** can include a venting element which defines a fluid path (illustrated by arrows **126**) to the internal volume of the housing **102** and the various components disposed within the internal volume of the housing **102**.

FIG. **1**D shows a block diagram of the portable electronic device **100** disposed in an ambient environment **128**. The block diagram of the portable electronic device **100** includes the housing **102**, the audio component assembly **118** having a membrane **130** and a venting element **132**, and a housing vent **134**. The membrane **130** can be non-porous or fluid impermeable and can include polytetrafluoroethylene (PTFE). The membrane **130** can have a thickness of about 10 microns, between about 3 microns and about 7 microns, between about 7 microns and about 12 microns, or less than about 30 microns. The membrane **130** and the audio component assembly **118** can define or otherwise form an audio component volume **136**.

The audio component volume **136** can experience a variance in relative pressure (e.g., a pressure within the audio component volume **136** relative to a pressure of an ambient environment **128** outside of the audio component volume **136**). For example, a variance in temperature and/or atmospheric pressure can vary the relative pressure within the audio component volume **136**. Fluctuations in relative pressure can degrade the membrane **130** or otherwise cause the audio component assembly **118** to perform poorly. In some examples, the audio component assembly **118** can include a membrane support (not shown). While the membrane support can be disposed adjacent the membrane **130** to limit inelastic deformation of the membrane **130**, the membrane support cannot entirely prevent degradation and damage to the membrane **130**. Accordingly, venting the audio component volume **136** can be beneficial to regulate the relative pressure within the audio component volume **136** and thereby prevent damage to the membrane **130**. In some examples, the venting element **132** can provide a fluid path (illustrated by arrow **126**) which places the audio component volume **136** in fluid communication with a volume defined by the housing (e.g., housing volume **138**). The housing volume **138** can be in fluid communication with the housing vent **134** to provide pressure regulation between the housing volume **138** and the ambient environment **128**. In other words, an absolute pressure within the housing volume **138** can be equalized or substantially equalized to an absolute pressure of the ambient environment **128**. Due to the venting element **132** providing fluid communication between the audio component volume **136** and the housing volume **138**, an absolute pressure within the audio component volume **136** can also be equalized or substantially equalized to the absolute pressure of the ambient environment **128** through the fluid path (illustrated as arrow **126**) which places the audio component volume **136** in fluid communication with the ambient environment **128** (i.e., through the housing volume **138** and the housing vent **134**).

Any number or variety of components in any of the configurations described herein can be included in the portable electronic device. The components can include any combination of the features described herein and can be arranged in any of the various configurations described herein. The structure and arrangement of components of a portable electronic device having a housing with structures described herein, and defining an internal volume, as well as the concepts regarding membranes and fluid paths, can apply not only to the specific examples discussed herein, but to any number of examples in any combination. An example of an audio component assembly of a portable electronic device including components having various features in various arrangements are described below, with reference to FIG. **2**.

FIG. **2** shows a cross-sectional view of an audio component assembly **200**. The audio component assembly **200** can include a case **202**, a grill **204**, a membrane **206**, a venting element **208**, a gasket or seal **210**, and electronic components **212**. The case **202** can include any desired material, such as polymeric materials or plastics. The case **202** can retain the other components of the audio component assembly **200** which can be affixed thereto. In some examples, the seal **210** can be affixed, bonded, or otherwise secured to the case **202**. The seal **210** can include a compliant material, such as a polymeric material like rubber or plastic. In some examples, the seal **210** can include silicone rubber. In some examples, the seal **210** can be overmolded onto the case **202** and can directly contact the case **202** and a housing of the portable electronic device (not shown) to provide a seal or barrier between the ambient environment (e.g., ambient environment **128**) and the internal volume of the device (e.g., housing volume **138**).

The grill **204** can be secured to the case **202** and can act as a physical barrier to prevent objects, such as dust or rocks, from damaging the audio component assembly **200**. The grill **204** can be permeable to air or liquid, and acoustic signals can pass therethrough to the membrane **206**. The membrane **206** can move relative to acoustic waves exerted on the membrane **206**. The electrical components **212** within the audio component assembly **200** can convert the movement of the membrane **206** into electrical signals which can be communicated to other components of a portable electronic device (e.g., portable electronic device **100**). For example, the electrical components **212** can include one or more magnets, coils, wires, plates, capacitors, batteries, resistors, transistors, inductors, a combination thereof, or any other electrical component which can be utilized to manufacture an audio component.

In some examples, the venting element **208** can include one or more fluid impermeable layers. In some examples, the fluid impermeable layer or layers can define a surface of the venting element. The membrane **206** and other elements of the audio component assembly **200** can define an audio component volume **214**. In some examples, where the audio component assembly **200** is included in the internal volume of an electronic device, the audio component volume **214** can be referred to as the second internal volume. For example, the membrane **206** and one or more of the case **202**, the seal **210**, and the electrical components **212** can form or define the audio component volume **214**. The venting element **208** can define a fluid path **216** which extends substantially parallel to the one or more fluid impermeable layers, and or one or more surfaces defined by the fluid impermeable layers, and places the audio component volume **214** in fluid communication with an internal volume of the device **238** (e.g., the housing volume **138** shown in FIG. **1**D). In some examples, the venting element **208** can be disposed adjacent the membrane **206** and can function as a membrane support element. That is, the venting element **208** can provide a backstop or a stiffener than interfaces with the membrane **206** when the membrane **206** is deformed into the venting element **208**. Additionally, or alternatively, the audio component assembly **200** can include a distinct and separate membrane support element disposed adjacent the venting element **208** (see FIGS. **4**A-**6**C).

Any number or variety of components in any of the configurations described herein can be included in the portable electronic device. The components can include any combination of the features described herein and can be arranged in any of the various configurations described herein. The structure and arrangement of components of a portable electronic device having a housing with structures described herein, and defining an internal volume, as well as the concepts regarding membranes and fluid paths, can apply not only to the specific examples discussed herein, but to any number of examples in any combination. Examples of audio component assemblies of a portable electronic device including components having various features in various arrangements are described below, with reference to FIGS. **3**A-**3**C.

FIG. **3**A shows a cross-sectional view of an audio component assembly **300** disposed within a housing **301** of a portable electronic device. The audio component assembly **300** can include a case **302**, a grill **304**, a membrane **306**, a venting element **308**, a gasket or seal **310**, and electrical components **312**. The case **302** can include substantially similar features and functionality as other cases described herein, for example, the case **202**. The grill **304** can include substantially similar features and functionality as other grills described herein, for example, the grill **204**. The membrane **306** can include substantially similar features and functionality as other membranes described herein, for example, the membrane **206**. The seal **310** can include substantially similar features and functionality as other seals described herein, for example, the seal **210**. The electrical components **312** can include substantially similar features and functionality as other electrical components described herein, for example, the electrical components **212**.

In some examples, the venting element **308** can include a fluid impermeable layer **314** and one or more apertures **316** extending through the venting element **308**. In some examples, the fluid impermeable layer **314** can define a surface of the venting element **308**. The fluid impermeable layer **314** can include a heat-activated film (HAF), a pressure sensitive adhesive tape (PSA), a thermoplastic elastomer (TPE), a combination thereof, or any another polymer-based material.

As shown in FIG. **3**B, the venting element **308** can be planar and form a circular profile. While the venting element **308** depicted in FIG. **3**B has a circular profile, the venting element **308** can have a profile resembling any geometric shape, such as, circular, ellipsoidal, rectangular, trapezoidal, triangular, a combination thereof, or any other geometric shape. The one or more apertures **316** can enable fluid communication between the membrane **306** and the electrical components **312**. For example, movement of the membrane **306** can cause air to travel through an internal volume **318** formed within the audio component assembly **300**. In the present example, the venting element **308** can function as a membrane support, as described herein.

The venting element **308** can function as a venting element which defines or forms a fluid path (depicted as arrow **317** in FIG. **3**A) that extends parallel or substantially parallel to the fluid impermeable layer **314**. The fluid path can place the internal volume **318** of the audio component assembly **300** in fluid communication with a volume outside of the audio component assembly **300**. For example, the fluid impermeable layer **314** can form or define a channel **320** which acts as the fluid path for placing the internal volume **318** in fluid communication with another volume outside of the audio component assembly **300**. The channel **320** can spiral from a central portion **322** of the venting element **308** to a periphery **324** of the venting element **308**. While the channel **320** is depicted as a spiral in FIG. **3**B, those skilled in the art will readily appreciate that the fluid path can be defined by one or more channels having any one of a multitude of shapes, lengths, and positions about the fluid impermeable layer **314**. In some examples, the venting element **308** can include one or more linear and/or curved channels each extending radially from the central portion **322** of the venting element **308** to the periphery **324** of the venting element **308**.

In some examples, the channel **320** can enable air to flow through the channel **320** to regulate a relative pressure within the internal volume **318** of the audio component assembly **300**. Additionally, or alternatively, the channel **320** can attenuate acoustic waves traveling within the channel **320** to reduce or prevent a loss in the functionality of the audio component assembly **300**. For example, the audio component assembly **300** can be disposed within a housing **301** of a portable electronic device and required to vent through the same portion of the housing **301** that forms the back-volume for a speaker of the portable electronic device. In this example, the fluid path defined by the channel **320** to vent relative pressure can also enable acoustic waves from the speaker to travel to the audio component assembly **300** (e.g., through the fluid path) and thereby decrease or diminish the functionality of the audio component assembly **300**. Thus, the channel **320** can be designed to reduce or otherwise attenuate acoustic waves travelling through the channel

320. For example, attributes of the channel **320** can be varied such that the channel **320** acts as a low pass filter which attenuates or reduces acoustic waves having wavelengths above 20 Hz.

Attributes of the channel **320** can include a width, a length, a depth, a cross-sectional geometry, or a combination thereof. Any of the width, the depth, and/or the cross-sectional geometry of the channel **320** can vary along the length of the channel **320**, for example, the width of the channel **320** can be narrower near the periphery **324** of the venting element **308** and broader near the central portion **322** of the venting element **308**. Similarly, the depth of the channel can be shallower near the periphery **324** of the venting element **308** and deeper near the central portion **322** of the venting element **308**. The cross-sectional shape (e.g., a shape of the channel **320** taken through the channel's length) can be rectangular, trapezoidal, circular, ellipsoidal, triangular, or any other geometric shape. Moreover, in some examples, the cross-sectional shape of the channel **320** can vary along the length of the channel **320**.

In some examples, the venting element **308** can include one or more protrusions positioned along a length of the channel **320**. As shown in FIG. **3**C, the venting element **308** can include multiple protrusions **326** disposed on a floor or base **328** of the channel **320**. The protrusions **326** can be disposed within the channel **320** to attenuate or further attenuate acoustic waves traveling through the channel **320**. Additionally, or alternatively, one or more of the protrusions **326** can be disposed on a sidewall **330** of the channel **320** to attenuate or further attenuate acoustic waves traveling through the channel **320**. Each of the protrusions **326** can extend from the base **328** and/or sidewall **330** of the channel **320**. The protrusions **326** can be deposited, printed, machined, adhered, affixed, etched, molded, or otherwise disposed on the base **328** and/or the sidewall **330** of the channel **320**.

While the channel **320** is described as being formed on the fluid impermeable layer **314** of the venting element **308**, in other examples, the channel **320** can also or alternatively be formed on a fluid impermeable layer of a separate and distinct venting element disposed adjacent the venting element **308**.

Any number or variety of components in any of the configurations described herein can be included in the portable electronic device. The components can include any combination of the features described herein and can be arranged in any of the various configurations described herein. The structure and arrangement of components of a portable electronic device having a housing with structures described herein, and defining an internal volume, as well as the concepts regarding membranes and fluid paths, can apply not only to the specific examples discussed herein, but to any number of examples in any combination. Examples of audio component assemblies of a portable electronic device including a venting element are described below, with reference to FIGS. **4**A-**7**F.

FIG. **4**A shows a cross-sectional view of an audio component assembly **400** disposed within a housing **401** of a portable electronic device. The audio component assembly **400** can include a case **402**, a grill **404**, a membrane **406**, a membrane support **408**, a gasket or seal **410**, electrical components **412**, and a venting element **414**. The case **402** can include substantially similar features and functionality as other cases described herein, for example, the case **202**, **302**. The grill **404** can include substantially similar features and functionality as other grills described herein, for example, the grill **204**, **304**. The membrane **406** can include substantially similar features and functionality as other membranes described herein, for example, the membrane **206**, **306**. The membrane support **408** can include substantially similar features and functionality as other membrane supports described herein, for example, the grill **204**, **304**. Alternatively, the membrane support **408** can be devoid of any channels (e.g., channel **320**) and simply provide support to the membrane as a stiffener (e.g., limiting inelastic deformation of the membrane **406**). The seal **410** can include substantially similar features and functionality as other seals described herein, for example, the seal **210**, **310**. The electrical components **412** can include substantially similar features and functionality as other electrical components described herein, for example, the electrical components **212**, **312**.

In some examples, the venting element **414** can be disposed adjacent the membrane support **408** and define a fluid path (depicted as arrow **417** in FIG. **4**A) which places an internal volume **416** of the audio component assembly **400** in fluid communication with a volume outside of the audio component assembly **400**. As shown in FIGS. **4**A-**4**C, the venting element **414** can include a first fluid impermeable layer **418**A, a second fluid impermeable layer **418**B, and a porous material **420** disposed between the first and second fluid impermeable layers **418**A, **418**B. In some examples, the fluid impermeable layers **418**A, **418**B can define surfaces of the venting element **414**. The porous material **420** can include metals, metal alloys, polymers, ceramics, or combinations thereof. For example, the porous material **420** can be made of a metal foam. The porous material **420** can be adhered or otherwise affixed to the first and second fluid impermeable layers **418**A, **418**B, for example, with adhesive, molding, welding, printing, or any other mechanism for affixing the first and second fluid impermeable layers **418**A, **418**B to the porous material **420**. The fluid path can extend from a central aperture **422** of the venting element **414** to a periphery **424** of the venting element **414**. One or more of the fluid impermeable layers **418**A, **418**B can include a heat-activated film (HAF), a pressure sensitive adhesive tape (PSA), a thermoplastic elastomer (TPE), a combination thereof, or any another polymer-based material.

Additionally, or alternatively, the porous material **420** can attenuate acoustic waves traveling within the venting element **414** to reduce or prevent a loss in the functionality of the audio component assembly **400**. For example, the audio component assembly **400** can be disposed within a housing **401** of a portable electronic device and required to vent through the same portion of the housing **401** that forms the back-volume for a speaker of the portable electronic device. In this example, the fluid path defined by the venting element **414** to vent relative pressure can also enable acoustic waves from the speaker to travel to the audio component assembly **400** (e.g., through the fluid path) and thereby decrease or diminish the functionality of the audio component assembly **400**. Thus, the venting element **414** can be designed to reduce or otherwise attenuate acoustic waves travelling through the venting element **414**. For example, attributes of the venting element **414** can be varied such that the venting element **414** acts as a low pass filter which attenuates or reduces acoustic waves having wavelengths above 20 Hz.

Attributes of the venting element **414** can include a porosity of the porous material **420**, a thickness of the porous material **420**, a diameter of the central aperture **422**, or a combination thereof. For example, relatively more fluid flow can be achieved through the venting element **414** when the porous material **420** has a relatively larger thickness and/or includes a material having a relatively high porosity.

As shown in FIG. **4**B, the venting element can be planar and form a circular profile. While the venting element depicted in FIG. **4**B has a circular profile, the venting element **414** can have a profile resembling any geometric shape, such as, circular, ellipsoidal, rectangular, trapezoidal, triangular, a combination thereof, or any other geometric shape. The central aperture **422** can enable fluid communication between the membrane **406** and the electrical components **412**. For example, movement of the membrane **406** can cause air to travel through the internal volume **416** formed within the audio component assembly **400**.

While the fluid path is described as being formed within the venting element **414**, in other examples, the fluid path can also or alternatively be formed within the membrane support **408**. For example, the membrane support **408** can include a porous material disposed between first and second fluid impermeable layers.

FIG. **5**A shows a cross-sectional view of an audio component assembly **500** disposed within a housing **501** of a portable electronic device. The audio component assembly **500** can include a case **502**, a grill **504**, a membrane **506**, a membrane support **508**, a gasket or seal **510**, electrical components **512**, and a venting element **514**. The case **502** can include substantially similar features and functionality as other cases described herein, for example, the case **202**, **302**, **402**. The grill **504** can include substantially similar features and functionality as other grills described herein, for example, the grill **204**, **304**, **404**. The membrane **506** can include substantially similar features and functionality as other membranes described herein, for example, the membrane **206**, **306**, **406**. The membrane support **508** can include substantially similar features and functionality as other membrane supports described herein, for example, the grill **204**, **304**. Alternatively, the membrane support **508** can be devoid of any channels (e.g., channel **320**) and simply provide support to the membrane as a stiffener (e g, limiting inelastic deformation of the membrane **506**). The seal **510** can include substantially similar features and functionality as other seals described herein, for example, the seal **210**, **310**, **410**. The electrical components **512** can include substantially similar features and functionality as other electrical components described herein, for example, the electrical components **212**, **312**, **412**.

In some examples, the venting element **514** can be disposed adjacent the membrane support **508** and define a fluid path which places an internal volume **516** of the audio component assembly **500** in fluid communication with a volume outside of the audio component assembly **500**. As shown in FIGS. **5**A-**5**C, the venting element **514** can include a first fluid impermeable layer **518**A, a second fluid impermeable layer **518**B, and a coil **520** disposed between the first and second fluid impermeable layers **518**A, **518**B. In some examples, the fluid impermeable layers **518**A, **518**B can define surfaces of the venting element **514**. The coil **520** can include metals, metal alloys, polymers, ceramics, or combinations thereof. For example, the coil **520** can be a coiled copper wire having a diameter of about 50 microns, less than 10 microns, between about 10 microns and about 20 microns, between about 20 microns and about 40 microns, between about 40 microns and about 60 microns, or less than about 200 microns.

The coil **520** can be adhered or otherwise affixed to the first and second fluid impermeable layers **518**A, **518**B using adhesive, welding, fasteners, molding, or a combination thereof. The coil **520** and the first and second fluid impermeable layers **518**A, **518**B can form gaps **526** within the venting element **514** which can define one or more fluid paths (depicted as arrow **517** in FIG. **5**A) through venting element **514**. The fluid path defined by the venting element **514** can extend from a central aperture **522** of the venting element **514** to a periphery **524** of the venting element **514**. One or more of the fluid impermeable layers **518**A, **518**B can include a heat-activated film (HAF), a pressure sensitive adhesive tape (PSA), a thermoplastic elastomer (TPE), a combination thereof, or any another polymer-based material.

Additionally, or alternatively, the venting element **514** can attenuate acoustic waves to reduce or prevent a loss in the functionality of the audio component assembly **500**. For example, the audio component assembly **500** can be disposed within a housing **501** of a portable electronic device and required to vent through the same portion of the housing **501** that forms the back-volume for a speaker of the portable electronic device. In this example, the fluid path defined by the venting element **514** to vent relative pressure can also enable acoustic waves from the speaker to travel to the audio component assembly **500** (e.g., through the fluid path) and thereby decrease or diminish the functionality of the audio component assembly **500**. Thus, the venting element **514** can be designed to reduce or otherwise attenuate acoustic waves travelling through the venting element **514**. For example, attributes of the venting element **514** can be varied such that the venting element **514** acts as a low pass filter which attenuates or reduces acoustic waves having wavelengths above 20 Hz.

Attributes of the venting element **514** can include a diameter of the coil **520**, a cross-sectional shape of the coil **520**, a size or volume of the gaps **526**, a diameter of the central aperture **522**, a number of turns that forms the coil **520**, or a combination thereof. For example, relatively more fluid flow can be achieved through the venting element **514** when the gaps **526** formed between the coil **520** and the first and second fluid impermeable layers **518**A, **518**B define a relatively large volume. Accordingly, the diameter of the coil **520**, the cross-sectional shape of the coil **520**, or a combination thereof can be manipulated to allow greater fluid flow through the gaps **526** within the venting element **514**.

As shown in FIG. **5**B, the venting element **514** can be planar and form a circular profile. While the venting element depicted in FIG. **5**B has a circular profile, the venting element **514** can have a profile resembling any geometric shape, such as, circular, ellipsoidal, rectangular, trapezoidal, triangular, a combination thereof, or any other geometric shape. The central aperture **522** can enable fluid communication between the membrane **506** and the electrical components **512**. For example, movement of the membrane **506** can cause air to travel through the internal volume **516** formed within the audio component assembly **500**.

While the fluid path is described as being formed within the venting element **514**, in other examples, the fluid path can also or alternatively be formed within the membrane support **508**. For example, the membrane support **508** can include a coil disposed between first and second fluid impermeable layers.

FIG. **6**A shows a cross-sectional view of an audio component assembly **600**. The audio component assembly **600** can include a case **602**, a grill **604**, a membrane **606**, a membrane support **608**, a gasket or seal **610**, electrical components **612**, and a venting element **614**. The case **602** can include substantially similar features and functionality as other cases described herein, for example, the case **202**, **302**, **402**, **502**. The grill **604** can include substantially similar features and functionality as other grills described herein, for example, the grill **204**, **304**, **404**, **504**. The membrane **606** can include substantially similar features and functionality as other membranes described herein, for example, the membrane **206**, **306**, **406**, **506**. The membrane support **608** can include substantially similar features and functionality as other membrane supports described herein, for example, the grill **204**, **304**, **404**, **504**. Alternatively, the membrane support **608** can be devoid of any channels (e.g., channel **320**) and simply provide support to the membrane as a stiffener (e g, limiting inelastic deformation of the membrane **606**). The seal **610** can include substantially similar features and functionality as other seals described herein, for example, the seal **210**, **310**, **410**, **510**. The electrical components **612** can include substantially similar features and functionality as other electrical components described herein, for example, the electrical components **212**, **312**, **412**, **512**.

In some examples, the venting element **614** can be disposed adjacent the membrane support **608** and define a fluid path which places an internal volume **616** of the audio component assembly **600** in fluid communication with a volume outside of the audio component assembly **600**. As shown in FIGS. **6A-6C**, the venting element **614** can include a first fluid impermeable layer **618**A, a second fluid impermeable layer **618**B, and a coiled tube **620** disposed between the first and second fluid impermeable layers **618**A, **618**B. In some examples, the fluid impermeable layers **618**A, **618**B can define surfaces of the venting element **614**. The coiled tube **620** can include metals, metal alloys, polymers, ceramics, or combinations thereof. For example, the coiled tube **620** can include a metal alloy tube coiled about a central axis. In some examples, the first and second fluid impermeable layers **618**A, **618**B can include a resin or curable adhesive which is poured over the coiled tube **620** to form the venting element **614**. As shown in FIG. **6**C, the first and second fluid impermeable layers **618**A, **618**B can be formed from a singular material which envelops the coiled tube **620**. Alternatively, the first and second fluid impermeable layers **618**A, **618**B can be formed from distinct segments of a material, such as, polytetrafluoroethylene (PTFE) or some other polymer which is adhered or otherwise affixed to the coiled tubing **620** using adhesive, welding, fasteners, molding, or a combination thereof. The coiled tube **620** can form a conduit **626** (i.e., a fluid path) extending from a central aperture **622** of the venting element **614** to a periphery **624** of the venting element **614**. The conduit **626** can be about 50 microns in diameter, less than 10 microns, between about 10 microns and about 20 microns, between about 20 microns and about 40 microns, between about 40 microns and about 60 microns, or less than about 200 microns in diameter.

Additionally, or alternatively, the venting element **614** can attenuate acoustic waves to reduce or prevent a loss in the functionality of the audio component assembly **600**. For example, the audio component assembly **600** can be disposed within a housing of a portable electronic device and required to vent through the same portion of the housing that forms the back-volume for a speaker of the portable electronic device. In this example, the fluid path defined by the venting element **614** to vent relative pressure can also enable acoustic waves from the speaker to travel to the audio component assembly **600** (e.g., through the fluid path) and thereby decrease or diminish the functionality of the audio component assembly **600**. Thus, the venting element **614** can be designed to reduce or otherwise attenuate acoustic waves travelling through the venting element **614**. For example, attributes of the venting element **614** can be varied such that the venting element **514** acts as a low pass filter which attenuates or reduces acoustic waves having wavelengths above 20 Hz.

Attributes of the venting element **614** can include an outer diameter of the coiled tube **620**, a cross-sectional shape of the coiled tube **620**, an inner diameter of the coiled tube **620** (e.g., the diameter of the conduit **626**), a diameter of the central aperture **622**, or a combination thereof. For example, relatively more fluid flow can be achieved through the venting element **614** when the inner diameter of the coiled tube **620** (e.g., the diameter of the conduit **626**) is relatively large. Accordingly, the diameter of the conduit **626** can be chosen which allows a greater quantity of fluid flow through the venting element **614**.

As shown in FIG. **6**B, the venting element **614** can be planar and form a circular profile. While the venting element depicted in FIG. **6**B has a circular profile, the venting element **614** can have a profile resembling any geometric shape, such as, circular, ellipsoidal, rectangular, trapezoidal, triangular, a combination thereof, or any other geometric shape. The central aperture **622** can enable fluid communication between the membrane **606** and the electrical components **612**. For example, movement of the membrane **606** can cause air to travel through the internal volume **616** formed within the audio component assembly **600**.

While the fluid path is described as being formed within the venting element **614**, in other examples, the fluid path can also or alternatively be formed within the membrane support **608**. For example, the membrane support **608** can include a coiled tube disposed between first and second fluid impermeable layers.

FIG. **7**A shows a cross-sectional view of an audio component assembly **700** disposed within a housing **701** of a portable electronic device. The audio component assembly **700** can include a case **702**, a grill **704**, a membrane **706**, a membrane support **708**, a gasket or seal **710**, electrical components **712**, and a venting element **714**. The case **702** can include substantially similar features and functionality as other cases described herein, for example, the case **202**, **302**, **402**, **502**. The grill **704** can include substantially similar features and functionality as other grills described herein, for example, the grill **204**, **304**, **404**, **504**. The membrane **706** can include substantially similar features and functionality as other membranes described herein, for example, the membrane **206**, **306**, **406**, **506**. The membrane support **708** can include substantially similar features and functionality as other membrane supports described herein, for example, the grill **208**, **204**, **304**, **404**, **504**. Alternatively, the membrane support **708** can be devoid of any channels (e.g., channel **320**) and simply provide support to the membrane as a stiffener (e.g., limiting inelastic deformation of the membrane **706**). The seal **710** can include substantially similar features and functionality as other seals described herein, for example, the seal **210**, **310**, **410**, **510**. The electrical components **712** can include substantially similar features and functionality as other electrical components described herein, for example, the electrical components **212**, **312**, **412**, **512**.

As shown in FIG. **7**B, the venting element **714** can be planar and form a circular profile. While the venting element **714** depicted in FIG. **7**B has a circular profile, the venting element **714** can have a profile resembling any geometric shape, such as, circular, ellipsoidal, rectangular, trapezoidal, triangular, a combination thereof, or any other geometric shape. The central aperture **722** can enable fluid communication between the membrane **706** and the electrical components **712**. For example, movement of the membrane **706** can cause air to travel through the internal volume **716** formed within the audio component assembly **700**.

While the fluid path is described as being formed within the venting element **714**, in other examples, the fluid path can also or alternatively be formed within the membrane support **708**. For example, the membrane support **708** can include a porous material disposed between first and second fluid impermeable layers.

In some examples, the venting element **714** can be disposed adjacent the membrane support **708** and define a fluid path (depicted as arrow **717** in FIGS. 7A and 7F) which places an internal volume **716** of the audio component assembly **700** in fluid communication with a volume outside of the audio component assembly **700**. As shown in FIGS. 7A-7F, the venting element **714** can include a first fluid impermeable layer **718**A, a second fluid impermeable layer **718**B, and a fluid permeable intermediate layer **720** disposed between the first and second fluid impermeable layers **718**A, **718**B. In some examples, the fluid impermeable layers **718**A, **718**B can define surfaces of the venting element **714**. The fluid permeable intermediate layer **720** can include metals, metal alloys, polymers, ceramics, or combinations thereof. For example, the fluid permeable intermediate layer **720** can be made of a porous metal such as a metal foam, a thermoplastic vulcanizate (TPV), or any other fluid permeable material. The fluid permeable intermediate layer **720** can be adhered or otherwise affixed to the first and second fluid impermeable layers **718**A, **718**B, for example, with adhesive, molding, welding, printing, or any other mechanism for affixing the first and second fluid impermeable layers **718**A, **718**B to the fluid permeable intermediate layer **720**. One or more of the fluid impermeable layers **718**A, **718**B can include a heat-activated film (HAF), a pressure sensitive adhesive tape (PSA), a thermoplastic elastomer (TPE), a combination thereof, or any another polymer-based material.

In examples, the fluid path can extend from a central aperture **722** or center portion of the venting element **714** to a periphery **724** of the venting element **714**. For example, the first fluid impermeable layer **718**A can at least partially form a first channel **726**A extending into the first fluid impermeable layer **718**A from the central aperture **722**. In some examples, the first channel **726**A can be formed by the first fluid impermeable layer **718**A and another component of the audio component assembly **700** (e.g., the membrane support **708**, or a pressure sensitive adhesive (PSA) between components of the audio component assembly). The first channel **726**A can have a width W_1 that varies along a length L_1 of the first channel **726**A. For example, the width W_1 of the first channel **726**A can be greater or wider adjacent the central aperture **722** and narrow as the first channel **726**A extends toward the periphery **724**.

In examples, the second fluid impermeable layer **718**B can at least partially form a second channel **726**B extending into the second fluid impermeable layer **718**B from the periphery **724**. In some examples, the second channel **726**B can be formed by the second fluid impermeable layer **718**B and another component of the audio component assembly **700** (e.g., a spacer **728**, or a pressure sensitive adhesive (PSA) between components of the audio component assembly). The second channel **726**B can have a width W_2 that varies along a length L_2 of the second channel **726**B. For example, the width W_2 of the second channel **726**B can be greater or wider adjacent the periphery **724** and narrow as the second channel **726**B extends toward the central aperture **722**.

As illustrated in FIGS. **7**B-**7**E, in some examples, each of the first and second channels **726**A, **726**B can be flared or spread to ease alignment of the first and second channels **726**A, **726**B during manufacturing. In other words, the first and second channels **726**A, **726**B can be slightly misaligned but still form the fluid path because less manufacturing accuracy is required to overlap the flared profile of each of the first and second channels **726**A, **726**B. While the first and second channels are illustrated in FIGS. **7**B-**7**E as triangular or flared, the profile or shape of each of the first and second channels **726**A, **726**B can resemble any geometric shape capable of providing the features disclosed herein. For example, one or more of the first and second channels **726**A, **726**B can resemble a triangle, circle, square, rectangle, trapezoid, rhombus, oval, pentagon, another geometric shape, a free-form shape, or a combination thereof.

FIG. **7**D shows top view of the venting element **714** including a region **730** of the fluid permeable intermediate layer **720** disposed between the first channel **726**A and the second channel **726**B. In other words, the first and second channels **726**A, **726**B overlap on either side of the fluid permeable intermediate layer **720** to form the region **730** which allows fluid (e.g., air) to flow between the first and second channels **726**A, **726**B. For example, the first channel **726**A can extend a distance D_1 into the first fluid impermeable layer **718**A from the central aperture **722** and the second channel **726**B can extend a distance D_2 into the second fluid impermeable layer **718**B from the periphery **724**. The sum of the distances D_1, D_2 can be greater than a total distance DT between the periphery **724** and the central aperture **722** such that the region **730** enables fluid (e.g., air) to flow between the first and second channels **726**A, **726**B. The first and second channels **726**A, **726**B and the region **730** can form at least a portion of the fluid path that enables pressure within the volume **716** to vent, for example, when the membrane **706** is biased by atmospheric pressure of an environment external to the portable electronic device.

In some examples, the distances D_1. D_2 can be equivalent or substantially equivalent. When the distance D_1 is equivalent or substantially equivalent to the distance D_2, the region **730** can be centered about the total distance D_T (e.g., centered about halfway between the periphery **724** and the central aperture **722**). In some examples, the distance D_1 can be greater or smaller than the distance D_2. When the distance D_1 is greater or smaller than the distance D_2, the region **730** can be positioned closer to either the central aperture **722** or the periphery **724**. For example, when the distance D_1 is greater than the distance D_2, the region **730** can be positioned nearer or closer to the periphery **724** than the central aperture **722**.

The respective distances (e.g., distance D_1 and distance D_2) to which the first and second channels **726**A, **726**B extend can form or define a size and a shape of the region **730**. For example, as shown in FIG. **7**E, relatively larger distances (e.g., distance D_3 and distance D_4) can form a relatively larger region **730** (i.e., larger than the region **730** formed by the distances D_1. D_2 shown in FIG. **7**D). The size of the region **730** of the fluid permeable intermediate layer **720** that enables fluid communication between the first and second channels **726**A, **726**B can be at least 0.005 mm^2, about 0.005 mm^2 to about 0.01 mm^2, about 0.01 mm^2 to about 0.03 mm^2, about 0.03 mm^2 to about 0.05 mm^2, about 0.05 mm^2 to about 0.07 mm^2, about 0.07 mm^2 to about 0.1 mm^2, or greater than 0.1 mm^2.

The size of the region **730**, a thickness of the fluid permeable intermediate layer **720**, and the material or materials of the fluid permeable intermediate layer **720** can dictate the quantity of fluid that can pass through the fluid path. In some examples, the thickness of the fluid permeable intermediate layer **720** can be at least 5 μm, about 5 μm to about 15 μm, about 15 μm to about 20 μm, about 20 μm to about 25 μm, about 25 μm to about 30 μm, about 30 μm to about 40 μm, about 40 μm to about 60 μm, or greater than 60 μm. In some examples, an airflow rate along the fluid path defined by the venting element **714** can be at least 0.5 SCCM at 0.1 bar, about 1 SCCM at 0.1 bar to about 1.5 SCCM at 0.1 bar, about 1.5 SCCM at 0.1 bar to about 2 SCCM at 0.1 bar, about 2 SCCM at 0.1 bar to about 4 SCCM at 0.1 bar, about 4 SCCM at 0.1 bar to about 8 SCCM at 0.1 bar, or greater than 8 SCCM at 0.1 bar. While this range of airflow rates are described with reference to the examples shown in FIGS. **7**A-**7**F, these airflow rates are equally applicable to the examples shown in FIGS. **2**-**6**C and the examples shown in FIGS. **8**-**10**.

Additionally, the fluid permeable intermediate layer **720** can attenuate acoustic waves traveling within the venting element **714** to reduce or prevent a loss in the functionality of the audio component assembly **700**. For example, the audio component assembly **700** can be disposed within a housing **701** of a portable electronic device and required to vent through the same portion of the housing **701** that forms the back-volume for a speaker of the portable electronic device. In this example, the fluid path defined by the venting element **714** to vent relative pressure can also enable acoustic waves from the speaker to travel to the audio component assembly **700** (e.g., through the fluid path) and thereby decrease or diminish the functionality of the audio component assembly **700**. Thus, the venting element **714** can be designed to reduce or otherwise attenuate acoustic waves travelling through the venting element **714**. For example, attributes of the venting element **714** can be varied such that the venting element **714** acts as a low pass filter which attenuates or reduces acoustic waves having wavelengths above 20 Hz. Attributes of the venting element **714** can include a porosity or permeability of the fluid permeable intermediate layer **720**, the thickness of the fluid permeable intermediate layer **720**, a diameter of the central aperture **722**, the area and size of the region **730**, respective thicknesses of the first and second fluid impermeable layers **718**A, **718**B, or a combination thereof.

FIG. **7**F shows a cross-sectional view of the venting element **714** including the first and second fluid impermeable layers **718**A, **718**B, the fluid permeable intermediate layer **720**, and the fluid path **717** extending through the region **730**. In some examples, the portion of the fluid path **717** that extends through the fluid permeable intermediate layer **720** can be tortuous or nonlinear to attenuate or reflect acoustic waves propagating along the fluid path **717**.

Any number or variety of components in any of the configurations described herein can be included in the portable electronic device. The components can include any combination of the features described herein and can be arranged in any of the various configurations described herein. The structure and arrangement of components of a portable electronic device having a housing with structures described herein, and defining an internal volume, as well as the concepts regarding membranes and fluid paths, can apply not only to the specific examples discussed herein, but to any number of examples in any combination. Examples of audio component assemblies of a portable electronic device including an enclosure are described below, with reference to FIGS. **8**-**10**.

FIG. **8** shows a cross-sectional view of a portable electronic device **800** including a housing **802** and an audio component assembly **804** disposed within the housing **802**. The audio component assembly **804** can include substantially similar features and components having the functionality as other audio component assemblies described herein, for example, any one or more of audio component assemblies **200**, **300**, **400**, **500**, **600**, **700**. For example, an audio component volume **806** can experience a variance in relative pressure (e.g., a pressure within the audio component volume **806** relative to a pressure of an ambient environment **808** outside of the audio component volume **806**). For example, a variance in temperature and/or atmospheric pressure can vary the relative pressure within the audio component volume **806**. Fluctuations in relative pressure can degrade components of the audio component assembly **804** (e.g., a membrane) or otherwise cause the audio component assembly **804** to perform poorly.

Accordingly, venting the audio component volume **806** can be beneficial to regulate the relative pressure within the audio component volume **806** and thereby prevent damage to the audio component assembly **804**. In some examples, a venting element (e.g., venting elements **132**, **208**, **308**, **414**, **514**, **614**, **714**) can provide a fluid path (illustrated by arrow **810**) which places the audio component volume **806** in fluid communication with an external volume **812** defined by the housing **802**. However, other components within the housing **802** can interfere or negatively impact the performance of the audio component assembly **804**. For example a speaker **814** disposed within the housing **802** can emit one or more acoustic waves **816** that can propagate through the fluid path **810** and negatively impact performance of the audio component assembly **804**.

In some examples, the audio component assembly **804** can include an enclosure **818** having one or more vents **820** that inhibit or prevent the one or more acoustic waves **816** from propagating into the audio component volume **806** but still provide fluid communication between the audio component volume **806** and the external volume **812**. In examples, the enclosure **818** can be fluid impermeable except at the vent **820**. The vent **820** can enable fluid communication between the audio component volume **806** and the external volume **812** such that a pressure differential between the audio component volume **806** and the ambient environment **808** can be at least partially equalized. The vent **820** can be formed from a material that enables fluid communication but otherwise at least partially attenuates acoustic waves **816**. For example, the vent **820** can include a porous material, such as, a metallic or polymer-based open-cell foam that enables fluid through the vent **820**. The vent **820** can be affixed to the enclosure **818** using an adhesive, one or more fasteners, molding, co-molding, welding (e.g., sonic welding), or a combination thereof. While the vent **820** is illustrated on a particular sidewall **824**B of the enclosure **818**, the vent **820** can be positioned on any sidewall (e.g., sidewalls **824**A, **824**B, **824**C) or other surface of the enclosure **818**.

The enclosure **818** can be directly coupled to the audio component assembly **804**, the housing **802** of the portable electronic device **800**, or a combination thereof. For example, the enclosure **818** can be press-fit, fastened, adhered, molded, or otherwise affixed to the audio component assembly **804** as shown in FIG. **8**. The enclosure **818** can at least partially form an intermediate volume **822** in fluid communication with both the audio component volume **806** and the external volume **812**. The enclosure **818** can include metals, ceramics, polymers, or combinations thereof. For example, the enclosure **818** can be formed from a stamped aluminum sheet or machined aluminum billet.

The enclosure **818** can be molded, machined, stamped, cast, or manufactured in any other method.

FIG. **9** shows a cross-sectional view of a portable electronic device **900** including a housing **902** and an audio component assembly **904** disposed within the housing **902**. The audio component assembly **904** can include substantially similar features and components having the functionality as other audio component assemblies described herein, for example, any one or more of audio component assemblies **200**, **300**, **400**, **500**, **600**, **700**, **804**. The audio component assembly **904** can define or form an audio component assembly volume **906**. A pressure within the volume **906** can vary relative to an atmospheric pressure of an ambient environment **908** outside of the housing **902**.

In some examples, a venting element (e.g., venting elements **132**, **208**, **308**, **414**, **514**, **614**, **714**) can provide a fluid path (illustrated by arrow **910**) which places the audio component volume **906** in fluid communication with an external volume **912** defined by the housing **902**. However, other components within the housing **902** can interfere or negatively impact the performance of the audio component assembly **904**. For example a speaker **914** disposed within the housing **902** can emit one or more acoustic waves **916** that can propagate through the fluid path **910** and negatively impact performance of the audio component assembly **904**.

In some examples, the audio component assembly **904** can be substantially surrounded by an enclosure **918** having one or more vents **920** that inhibit or prevent the one or more acoustic waves **916** from propagating into the audio component volume **906** but still provide fluid communication between the audio component volume **906** and the external volume **912**. In examples, the enclosure **818** can be fluid impermeable except at the vent **820**. The vent **920** can enable fluid communication between the audio component volume **906** and the external volume **912** such that a pressure differential between the audio component volume **906** and the ambient environment **908** can be equalized. The vent **920** can be formed from a material that enables fluid communication but otherwise at least partially attenuates acoustic waves **916**. For example, the vent **920** can include a porous material, such as, a metallic or polymer-based open-cell foam that enables fluid through the vent **920**. The vent **920** can be affixed to the enclosure **918** using an adhesive, one or more fasteners, molding, co-molding, welding (e.g., sonic welding), or a combination thereof. While the vent **920** is illustrated on a particular sidewall **924**B of the enclosure **918**, one or more vents **920** can be positioned on one or more sidewalls (e.g., sidewalls **924**A, **924**B, **924**C) or any other surface of the enclosure **918**.

The enclosure **918** can be directly coupled to the audio component assembly **904**, the housing **902** of the portable electronic device **900**, or a combination thereof. For example, the enclosure **918** can be fastened, adhered, molded, or otherwise affixed to the housing **902**. The enclosure **918** can at least partially form an intermediate volume **922** in fluid communication with both the audio component volume **906** and the external volume **912**. The enclosure **918** can include metals, ceramics, polymers, or combinations thereof. For example, the enclosure **918** can be formed from a stamped aluminum sheet or machined aluminum billet. The enclosure **918** can be molded, machined, stamped, cast, or manufactured in any other method.

FIG. **10** shows a cross-sectional view of a portable electronic device **1000** including a housing **1002** and an audio component assembly **1004** disposed within the housing **1002**. The audio component assembly **1004** can include substantially similar features and components having the functionality as other audio component assemblies described herein, for example, any one or more of audio component assemblies **200**, **300**, **400**, **500**, **600**, **700**, **804**, **904**. The audio component assembly **1004** can define or form an audio component assembly volume **1006**. A pressure within the volume **1006** can vary relative to an atmospheric pressure of an ambient environment **1008** outside of the housing **1002**.

In some examples, a venting element (e.g., venting elements **132**, **208**, **308**, **414**, **514**, **614**, **714**) can provide a fluid path (illustrated by arrow **1010**) which places the audio component volume **1006** in fluid communication with an external volume **1012** defined by the housing **1002**. However, other components within the housing **1002** can interfere or negatively impact the performance of the audio component assembly **1004**. For example a speaker **1014** disposed within the housing **1002** can emit one or more acoustic waves **1016** that can propagate through the fluid path **1010** and negatively impact performance of the audio component assembly **1004**.

In some examples, the audio component assembly **1004** can be substantially surrounded by an enclosure **1018** that inhibits or limits the one or more acoustic waves **1016** from propagating into the audio component volume **1006** but still provide fluid communication between the audio component volume **1006** and the external volume **1012**. In examples, the enclosure **1018** can be fluid permeable to enable fluid communication between the audio component volume **1006** and the external volume **1012** such that a pressure differential between the audio component volume **1006** and the ambient environment **1008** can be equalized. The enclosure **1018** can be formed from one or more materials that enable fluid communication but otherwise at least partially attenuates acoustic waves **1016**. For example, the enclosure **1018** can include a fluid permeable layer **1020**, such as, a metallic or polymer-based open-cell foam that enables fluid flow through the enclosure **1018** while reducing or impeding acoustic waves from propagating into the audio component volume **1006**. The fluid permeable layer **1020** can be affixed to a support structure **1022** positioned around the audio component assembly **1004**.

In examples, the support structure **1022** can be a rigid structure that supports the fluid permeable layer **1020** in a fixed position relative to the audio component assembly **1004**. For example, the support structure **1022** can be stamped, machined, cast, or molded from a semi-rigid materials, such as, a polymer, a ceramic, a metal, or a combination thereof.

The enclosure **1018** can be directly coupled to the audio component assembly **1004**, the housing **1002** of the portable electronic device **1000**, or a combination thereof. For example, the enclosure **1018** can be fastened, adhered, molded, or otherwise affixed to the housing **1002**. The enclosure **1018** can at least partially form an intermediate volume **1026** in fluid communication with both the audio component volume **1006** and the external volume **1012**.

To the extent applicable to the present technology, gathering and use of data available from various sources can be used to improve the delivery to users of invitational content or any other content that may be of interest to them. The present disclosure contemplates that in some instances, this gathered data may include personal information data that uniquely identifies or can be used to contact or locate a specific person. Such personal information data can include demographic data, location-based data, telephone numbers, email addresses, TWITTER® ID's, home addresses, data or records relating to a user's health or level of fitness (e.g., vital signs measurements, medication information, exercise information), date of birth, or any other identifying or personal information.

The present disclosure recognizes that the use of such personal information data, in the present technology, can be used to the benefit of users. For example, the personal information data can be used to deliver targeted content that is of greater interest to the user. Accordingly, use of such personal information data enables users to calculated control of the delivered content. Further, other uses for personal information data that benefit the user are also contemplated by the present disclosure. For instance, health and fitness data may be used to provide insights into a user's general wellness, or may be used as positive feedback to individuals using technology to pursue wellness goals.

The present disclosure contemplates that the entities responsible for the collection, analysis, disclosure, transfer, storage, or other use of such personal information data will comply with well-established privacy policies and/or privacy practices. In particular, such entities should implement and consistently use privacy policies and practices that are generally recognized as meeting or exceeding industry or governmental requirements for maintaining personal information data private and secure. Such policies should be easily accessible by users, and should be updated as the collection and/or use of data changes. Personal information from users should be collected for legitimate and reasonable uses of the entity and not shared or sold outside of those legitimate uses. Further, such collection/sharing should occur after receiving the informed consent of the users. Additionally, such entities should consider taking any needed steps for safeguarding and securing access to such personal information data and ensuring that others with access to the personal information data adhere to their privacy policies and procedures. Further, such entities can subject themselves to evaluation by third parties to certify their adherence to widely accepted privacy policies and practices. In addition, policies and practices should be adapted for the particular types of personal information data being collected and/or accessed and adapted to applicable laws and standards, including jurisdiction-specific considerations. For instance, in the US, collection of or access to certain health data may be governed by federal and/or state laws, such as the Health Insurance Portability and Accountability Act (HIPAA); whereas health data in other countries may be subject to other regulations and policies and should be handled accordingly. Hence different privacy practices should be maintained for different personal data types in each country.

Despite the foregoing, the present disclosure also contemplates examples in which users selectively block the use of, or access to, personal information data. That is, the present disclosure contemplates that hardware and/or software elements can be provided to prevent or block access to such personal information data. For example, in the case of advertisement delivery services, the present technology can be configured to allow users to select to "opt in" or "opt out" of participation in the collection of personal information data during registration for services or anytime thereafter. In another example, users can select not to provide mood-associated data for targeted content delivery services. In yet another example, users can select to limit the length of time mood-associated data is maintained or entirely prohibit the development of a baseline mood profile. In addition to providing "opt in" and "opt out" options, the present disclosure contemplates providing notifications relating to the access or use of personal information. For instance, a user may be notified upon downloading an app that their personal information data will be accessed and then reminded again just before personal information data is accessed by the app.

Moreover, it is the intent of the present disclosure that personal information data should be managed and handled in a way to minimize risks of unintentional or unauthorized access or use. Risk can be minimized by limiting the collection of data and deleting data once it is no longer needed. In addition, and when applicable, including in certain health related applications, data de-identification can be used to protect a user's privacy. De-identification may be facilitated, when appropriate, by removing specific identifiers (e.g., date of birth, etc.), controlling the amount or specificity of data stored (e.g., collecting location data a city level rather than at an address level), controlling how data is stored (e.g., aggregating data across users), and/or other methods.

Therefore, although the present disclosure broadly covers use of personal information data to implement one or more various disclosed examples, the present disclosure also contemplates that the various examples can also be implemented without the need for accessing such personal information data. That is, the various examples of the present technology are not rendered inoperable due to the lack of all or a portion of such personal information data. For example, content can be selected and delivered to users by inferring preferences based on non-personal information data or a bare minimum amount of personal information, such as the content being requested by the device associated with a user, other non-personal information available to the content delivery services, or publicly available information.

The foregoing description, for purposes of explanation, used specific nomenclature to provide a thorough understanding of the described examples. However, it will be apparent to one skilled in the art that the specific details are not required in order to practice the described examples. Thus, the foregoing descriptions of the specific examples described herein are presented for purposes of illustration and description. They are not target to be exhaustive or to limit the examples to the precise forms disclosed. It will be apparent to one of ordinary skill in the art that many modifications and variations are possible in view of the above teachings.

What is claimed is:

1. An electronic device, comprising:
- a housing at least partially defining a first internal volume; and
- an audio component defining a second internal volume, the audio component comprising:
  - a membrane; and
  - a venting element defining a fluid path and comprising:
    - a first fluid impermeable layer defining a first channel;
    - a second fluid impermeable layer defining a second channel at least partially overlapping the first channel; and
    - a fluid permeable layer between the first fluid impermeable layer and the second fluid impermeable layer;
- wherein the fluid path extends from the first internal volume to the second internal volume.

2. The electronic device of claim **1**, wherein the first channel extends into the first fluid impermeable layer a first distance, and the second channel extends into the second fluid impermeable layer a second distance.

3. The electronic device of claim **2**, wherein a sum of the first distance and the second distance is greater than a third distance measured between a periphery of the first and second fluid impermeable layers and a central aperture of the first and second fluid impermeable layers.

4. The electronic device of claim **3**, wherein an overlapping region of the first channel and the second channel is positioned closer to the periphery than the central aperture.

5. The electronic device of claim **2**, wherein the first distance and the second distance are equivalent.

6. The electronic device of claim **1**, wherein the first channel comprises a first channel width and the second channel comprises a second channel width.

7. The electronic device of claim **6**, wherein at least one of the first channel width or the second channel width varies along a channel length.

8. The electronic device of claim **7**, wherein:

the first channel width is wider at a periphery of the first and second fluid impermeable layers and narrows toward a central aperture of the first and second fluid impermeable layers; and

the second channel width is wider at the central aperture and narrows toward the periphery.

9. An audio component, comprising:

a case at least partially defining an internal volume;

a membrane at least partially defining the internal volume; and

a venting element in fluid communication with the internal volume, the venting element defining a fluid path extending from the internal volume to an environment external to the case, and the venting element comprising:

a first fluid impermeable layer;

a second fluid impermeable layer; and

a coiled tube between the first fluid impermeable layer and the second fluid impermeable layer, wherein the fluid path extends through a conduit of the coiled tube.

10. The audio component of claim **9**, wherein the coiled tube comprises at least one of a metal material, a metal alloy material, a polymer material, or a ceramic material.

11. The audio component of claim **9**, wherein the fluid path comprises a spiral pattern at least partially encircling a central aperture of the venting element.

12. The audio component of claim **9**, wherein;

the coiled tube is a first coiled tube and the conduit is a first conduit; and

the venting element comprises a second coiled tube adjacent to the first coiled tube, the fluid path extending through a second conduit of the second coiled tube.

13. The audio component of claim **9**, wherein the first fluid impermeable layer and the second fluid impermeable layer comprise a resin material or a curable adhesive forming a singular material enveloping the coiled tube.

14. The audio component of claim **9**, wherein the first fluid impermeable layer and the second fluid impermeable layer comprise distinct material segments adhered to the coiled tube.

15. The audio component of claim **9**, wherein the venting element is configured to attenuate acoustic waves.

16. The audio component of claim **15**, wherein the acoustic waves filterable by the venting element comprise wavelengths above 20 Hertz.

17. The audio component of claim **9**, further comprising a membrane support positioned adjacent to the venting element.

18. A venting element for a portable electronic device, comprising:

a first fluid impermeable layer defining a first surface of the venting element;

a second fluid impermeable layer defining a second surface of the venting element opposite the first surface; and

a fluid permeable layer comprising a coil disposed adjacent the first fluid impermeable layer and the second fluid impermeable layer, the fluid permeable layer defining a fluid path extending from a central portion of the venting element to a periphery of the venting element along gaps between the first fluid impermeable layer, the second fluid impermeable layer, and the coil.

19. The venting element of claim **18**, wherein;

the coil is a first coil, and the fluid permeable layer comprises a second coil positioned adjacent to the first coil; and

the second coil further defines the gaps between the first fluid impermeable layer, the second fluid impermeable layer, and the first coil.

20. The venting element of claim **18**, wherein the first fluid impermeable layer and the second fluid impermeable layer include discrete layers comprising at least one of a heat-activated film, a pressure sensitive adhesive tape, or a thermoplastic elastomer.

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